NATURE

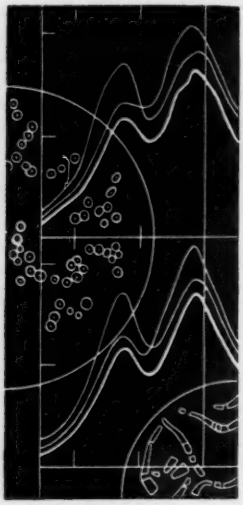
No. 4502 SATURDAY, FEBRUARY 11, 1956 Vol. 177

CONTENTS

	Page
Preservation of the Countryside in Britain	245
Language of the Emotions. By Prof. John Cohen	247
American Methods of Materials Testing. By K. J. Pascoe	248
Detergents in the Factory. By R. E. Wagg	249
Organic Reactions. By Prof. John Read, F.R.S.	249
New Methods of School Teaching in Australia	250
Social Analysis of Life in a Mental Hospital. By Dr. G. M. Carstairs	250
Organization of Defence Research in Britain. By Chapman Pincher	251
Automatic Control in the Process Industries	252
Agostino Bassi, 1773–1856. By Dr. G. C. Ainsworth	255
Obituaries :	
Dr. Arthur Felix, F.R.S. By Dr. G. S. Wilson	257
Prof. James Small. By Prof. J. Heslop Harrison	258
Prof. D. R. Boyd. By Prof. N. K. Adam, F.R.S.	259
Prof. P. N. Chirvinsky. By Dr. S. I. Tomkeieff	259
News and Views	260
The Nature Conservancy : Annual Report	264
The National Parks Commission, Great Britain : Annual Report	265
The Development of the Polarograph	266
The Geographical Association : Annual Conference. By R. C. Honeybone	267
Theoretical Physics : Symposium at St. Andrews. By Prof. J. F. Allen, F.R.S.	268
Children's Film Foundation	269
Fresh Water from Salt Water	270
Laboratory Technicians	270
Distribution of 8-Azaguanine in the Nucleic Acids of *Bacillus cereus*. By Dr. R. E. F. Matthews and Dr. J. D. Smith	271
Variations in the Amount of Feulgen Stain in Nuclei of Plants grown at Different Temperatures. By Dr. L. F. La Cour, Dr. E. M. Deeley and Dr. J. Chayen	272
Letters to the Editors :	
An Electron Microscopical Study of the Histochemical Localization of Alkaline Phosphatase in the Cell Wall of *Chlorella vulgaris*.—Dr. D. Brandes and Dr. R. N. Elston	274
Analysis of Crystalline Hæmoglobin Derivatives by Paramagnetic Resonance.—J. E. Bennett and Dr. D. J. E. Ingram	275
Spectrophotometric Method for the Estimation of Vitamin K_3.—Vanamala Sathe, J. B. Dave and Dr. C. V. Ramkrishnan	276
The 'Queen-Substance' of Honeybees and the Ovary-inhibiting Hormone of Crustaceans.—Dr. David B. Carlisle and Dr. Colin G. Butler	276
An Erythrocyte Sphering Factor in Rat and Mouse Plasma.—Dr. R. Barer and F. M. Gaffney	277
A Method for determining the Duration of Action of the Cardiac Glycosides.—M. Rand and Anne Stafford	278
Biosynthesis of Fatty Acids by Seeds of *Ricinus communis*.—N. Coppens	279
A Synthetic Growth Medium for the Trypanosomid Flagellate *Strigomonas* (*Herpetomonas*) *oncopelti*.—B. A. Newton	279
Resolution by means of a Micro-organism of Racemic Diaminosuccinic Acid and Determination of its Configuration.—Sakaru Suzuki, Hisao Makishima and Noboru Suzuki	280
Separation of Unstable Oxidation Intermediates of Cysteine.—Dr. G. Toennies and J. J. Kolb	281
Insect Mobility and Design of Field Experiments.—R. J. V. Joyce	282
A Combinatorial Design for Experiments with Alternative Responses.—K. Strzemienski	283
Relationship between Photosynthesis and a Homogeneous Protein Component of Plant Cytoplasm.—Dr. J. W. Lyttleton	283
A Simple Method of assessing the Moisture exuded through the Skin of Cattle.—R. M. Mabon	284
Thermionic Constants of Semi-Conductors.—Sir K. S. Krishnan, F.R.S., and Dr. S. C. Jain	285
Use of Krypton-85 in measuring Gas Clean-up Rates.—Dr. D. J. Harris and Dr. P. O. Hawkins	285
Changes in Lattice Constant of Cr_2O_3 near the Curie Temperature.—Selma Greenwald	286
Colour Centres in Metaphosphate Glass.—James H. Schulman ; Sadhan Basu	287
Reproduction of Potato Root Eelworm during the Winter in a Potato Clamp.—T. J. Legowski and E. B. Brown	287
Migration of Nematodes.—H. R. Wallace	287
Prevention of Toxæmia of Late Pregnancy in Sheep.—H. B. Parry	288
A Bathynellid from the New World.—Sebastian A. Gerlach and Rolf Siewing	289
Corrosion and Shell Composition in Barnacles.—H. Barnes	290
Dimorphism in the Portuguese Man-of-War.—A. K. Totton and G. O. Mackie	290

BOOKS ON SPECIALIZED SUBJECTS

Books on science, research, electronics, industrial work, electrical and mechanical engineering can be quickly supplied through your local Smith's shop or bookstall. College and works librarians and students, particularly, are invited to ask for lists of books on any subject. Any books not stocked locally will be quickly obtained from Head Office.



Your stationery and printed matter can also be supplied through our local branch.

W. H. SMITH & SON

FOR SCIENTIFIC BOOKS

Head Office: STRAND HOUSE, LONDON, W.C.2

TWO NEW BOOKS

THE HISTORY OF THE TELESCOPE

HENRY C. KING, Ph.D., M.Sc.

Foreword by Sir Harold Spencer Jones, F.R.S. late Astronomer Royal

Crown 4to. 456 pages. Very fully illustrated in line and half-tone. **Price 50s. net.**

THE ANALYSIS OF MINERALS & ORES OF THE RARER ELEMENTS

Being the Third Edition of the well-known "Schoeller and Powell" and extensively revised by

A. R. POWELL, F.R.S.

Medium 8vo. 408 pages. **Price 60s. net**

GRIFFIN *Established 1820* **DRURY LANE** **LONDON**

Second-hand Books

ON

PURE AND APPLIED SCIENCE

STANDARD WORKS : SETS OF SCIENTIFIC JOURNALS, OLD AND RARE SCIENTIFIC BOOKS

LARGE OR SMALL COLLECTIONS BOUGHT

H. K. LEWIS & Co. Ltd.

LONDON: 136, GOWER STREET, W.C.1

Telephone: EUSton 4282 (7 lines) Established 1844

The SCIENTIFIC BOOK SUPPLY SERVICE

(T. FREDERICK DE LOCHE)

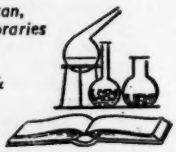
LIBRARIES PURCHASED

Consult us whenever you wish to buy or sell

HIGHEST PRICES PAID

Suppliers to American, Colonial & Foreign Libraries

Specialists in Scientific Books & Periodicals



PHONE: FLEET STREET 1294

5 FETTER LANE, FLEET STREET, LONDON, E.C.4

PRECISION BS INSTRUMENTS

Spectrograph ***with quartz optical system***

Critical definition is obtained over the entire range of the spectrum. Size of photographic plate 12 in. × 3 in.

A larger instrument can now be supplied giving a 12 in. length of spectrum between 8000A and 2100A.

Full particulars from the Manufacturers:

Bellingham & Stanley Ltd. DEPT. N, 71 HORNSEY RISE, LONDON, N.19

PRESERVATION OF THE COUNTRYSIDE IN BRITAIN

EVEN a cursory reading of the sixth annual report of the National Parks Commission, which reports to the Minister of Housing and Local Government, and that of the Nature Conservancy, which reports to the Lord President of the Council, cannot fail to reveal how much the two bodies have in common (see p. 264 of this issue). The latter is essentially a scientific body, the work of which is of profound importance to agriculture and forestry, water supply, coastal defence and meteorology, and for decisions about the use of land in general. None the less, sound policies of conservation depend at every step on scientific research carried out in intimate contact with land management and advisory and educational work, and the Conservancy is already finding it increasingly difficult to maintain a policy of free access in face of thoughtlessness and destructiveness on the part of a minority of the public. The National Parks Commission likewise finds increasing need for public support and understanding and, at the Conference of Park Planning Authorities which he convened last July, the Minister of Housing and Local Government said that in the end the only sure guardians of the national parks are the people themselves; national parks will be assured of the money they need and safe against encroachment or mutilation to the extent that the public visits them and values them.

What are required above all, by the Nature Conservancy no less than by the Park Planning Authorities and the National Parks Commission, are the support, encouragement and stimulus of an informed and critical public opinion; and these must come, not merely from the comparatively small number of enlightened workers in the open-air and scientific societies, to whom the Commission and Conservancy and the country at large owe so much, but also from an awakened public conscience throughout Britain. This is as true of the work of both bodies generally as it is in respect of problems, such as the study of the restoration, or even the maintenance, of the Broads, which they are handling in collaboration. The creation of local nature reserves or the voluntary action by national and county trusts and societies, for which the Nature Conservancy pleads, can only come as a result of that understanding and support.

Both reports contain encouraging evidence of the growth of such understanding and of increasing willingness to co-operate, just as they indicate how much more is required. The proper enforcement of the Protection of Birds Act, 1954, which is of vital concern to the Conservancy, on account of its responsibility for nature reserves and other areas which are or will be sanctuaries, ultimately rests on the inculcation of a wider understanding and knowledge of birds. The response to the Conservancy's letters to owners of sites of special scientific interest, however, has been most encouraging and appears to testify to the existence of a large fund of goodwill and readiness to co-operate, although in Scotland only a start has been made with such notifications and systematic notification in Wales has not yet begun.

The National Parks Commission regards its expanding activity in the field of information and publicity accordingly as of primary importance, and this is no less true of the Nature Conservancy. In this field of education it is probable that the official efforts of the two bodies could be supplemented by that of voluntary bodies such as the open-air societies and various scientific societies, both professional and amateur. The efforts of such bodies are, however, limited, like that of the Conservancy and the Commission themselves, by lack of finance, and here we touch on a second common note in both reports.

The Nature Conservancy points out that, as was forecast last year, its meagre grant-in-aid of £154,500 was quite inadequate for a programme of scientific work that already promises to yield returns within even a few years that will write off its cost many times over. Work on the fencing of reserves and on long overdue woodland operations has had to be postponed, as well as surveys and experiments, and grants for scientific studies and for postgraduate training had to be cut to an entirely inadequate level while the burden of rehabilitating and bringing into a satisfactory state of management even the existing reserves is rapidly increasing.

This failure to provide the necessary funds for research and conservation, including the acquisition of nature reserves, must result in loss or damage which will be felt by science and by the community many years after the transient minute saving in the current national budget has been forgotten. The point is not laboured by the Nature Conservancy, which is largely content to let its scientific record speak for itself; but it says little for the Lord President of the Council or the Committee of the Privy Council for Agricultural Research and Nature Conservancy, that the challenge presented no less clearly and firmly in the Conservancy's previous report has received no comment during the year. The position of the Nature Conservancy in the nation's organization for research appears to be long overdue for reconsideration, and should be pressed in the debates on the Agricultural Research Bill now before Parliament.

The matter is one which might well receive urgent attention from the Parliamentary and Scientific Committee, for an adequately financed Nature Conservancy is in a position to contribute out of all proportion to magnitude of effort. Both in ecological research and in conservation, success depends upon the fullest understanding and team-work between specialists who, but for the Conservancy, with its comprehensive responsibilities, might never meet. Already, with scanty resources, the Conservancy can report encouraging progress in promoting contacts, in initiating ecological studies and filling gaps, with benefits to biological research at the universities

as well as to the Conservancy's own work; and it should not be overlooked in this connexion that the main recommendation from an inspection of the Conservancy's administration which the Organization and Methods Division of the Treasury was invited to make during the year was that conservancy should be recognized as the central executive task of the Conservancy, thus reducing the conflicting responsibilities of research scientists in applied scientific fields.

The responsibility for seeing that the financial needs of the Nature Conservancy are adequately met thus clearly lies with the Lord President of the Council; but scientists working in related fields also have a responsibility for seeing that their professional bodies make effective representations on the matter to the appropriate research councils. The financial needs of the National Parks Commission are also acute; but the position is entirely different and the prospects of an early improvement appear to be somewhat brighter provided effective public support is forthcoming. It will be noted that the report of the National Parks Commission gives no information on finance, although it is made plain year after year that the difficulties in administration arise mainly because the cost of administering and improving or safeguarding the national parks has been thrown essentially on the local authorities. The Commission has never been provided with funds of its own adequate, for example, to pay the cost of some measure required to safeguard amenity in a park area which it is manifestly unreasonable to expect an individual owner or even a local authority to bear unaided, even if they had sufficient resources.

The purposes for which the Exchequer may pay grants amounting to 75 per cent of the total are detailed in the National Parks and Access to the Countryside (Grants) Regulations, 1954; but when it is realized that even a park authority warmly commended by the Commission for its activity and vigilance, such as the Peak Park Planning Board, spent less than £1,000 out of £27,000 on positive functions, thus qualifying for grant in the period April 1952–March 1954, and that the estimated expenditure of the Commission in 1953–54 was only £21,114, the parsimony with which the national parks in Britain are treated is obvious. In an earlier report the Commission had even had to record its inability to find the funds for printing the 'Country Code'.

The Conference of Park Planning Authorities last July also discussed a proposal that legislation should be introduced to make available from the National Land Fund moneys to be applied for national parks purposes. In July 1954 a report from the Committee on Public Accounts had recommended to the Treasury consideration of the desirability of legislation to return to the Exchequer some part of the large and growing balance of the National Land Fund, as being in the Committee's view a substantial amount of public money for which there was no foreseeable need. In 1946 the then Chancellor of the Exchequer had specifically mentioned the possible use of the fund for national parks purposes, and the Commission now expresses the view that use of such moneys in this way would be in line with the original intention of the Fund and provide an earnest of the Government's positive interest in national parks. It believes that if a specified sum were made available annually for a number of years ahead, both the Park Planning Authorities and the Commission could make forward plans on long-term projects, and initiate and promote a really effective national parks programme.

These views were urged on the Minister by the Commission in a letter dated February 24, 1955; but the Minister replied that the suggested provision could not be provided in the 1955 Finance Bill but would require a special Act. It is proposed accordingly to press the Minister to find some way by which grants from the Fund can be made available, and in the meantime some suggestions are made for amendment of the National Parks and Access to the Countryside Act, 1949, which should go far to remove this main weakness of the Act—not so much that the principal responsibility for administration of the parks should rest with the local authorities as that the financial burden should be borne by them. The Commission would remove, for example, the 75 per cent limit on the maximum grant and extend the purposes for which grant is payable to include, for instance, the creation of new footpaths and bridleways, the maintenance of warden services, the organization of information services, and anti-litter work. It also suggests that contribution should be payable to a developer in a national park area in respect of additional expenditure incurred by reason of conditions attached to planning consent in the interest of amenity, and that grants should also be permitted toward the administrative expenses of park planning authorities and towards administrative expenses incurred by local authorities in completing long-distance routes.

The Commission believes that amendment of the Act of 1949 on these lines and financial provision from the National Land Fund would give a new impulse to the creative side of national parks administration, the beneficent results of which would soon become apparent. Adequate financial provision, however imperative and beneficial, would not in itself remove the chief danger which threatens the work of both the Nature Conservancy and the National Parks Commission. That danger is the encroachment on national park areas and nature reserves, whether contemplated or already designated or declared, by the Service departments, the public corporations and even local authorities. The two most glaring instances cited in the present report are the decision of the Derbyshire County Council in principle to support a private Bill in the House of Commons for the establishment of a motor-racing circuit on public roads in the Peak District National Park, and the Manchester Corporation's objections to the route of the Pennine Way in the Longdendale valley.

The National Parks Commission, having inspected two alternative proposals by the Derbyshire County Council, is unable to see how any possible proposals would be consistent with the maintenance of the area

as a national park. The action of the Derbyshire County Council can, of course, be rectified by alert public opinion when at last the Bill is presented to Parliament, and such public opinion, as Mr. Duncan Sandys has pointed out, is the only ultimate safeguard. In the Longdendale dispute, the Minister has upheld the contention of the Manchester Corporation, in the face of the sustained protest of the National Parks Commission; with an alert and informed public opinion, the proposal would never have been made.

The irruption of party politics into local government may be one factor that has made the larger local authorities less alert and responsive to the claims of amenity and nature conservation than they should be. The major threats, however, still come from the Service departments and the large public corporations, although both the Nature Conservancy and the National Parks Commission in these reports refer to an increasing readiness of the Service departments to consult with them on their proposals and to steps taken to facilitate consultation at the earliest possible stage. None the less, at the close of the year, the Conservancy was objecting to a number of major projects, adoption of which would involve heavy damage to the scientific interest of St. Kilda and Loch Druidibeg in the Outer Hebrides, the geologically important parallel roads of Glen Roy in Inverness, Bilston Glen in Midlothian, the fine beech woods near Aston Rowant and the important Breckland area at Cavenham Heath. There is also concern as to the effect on wild life of the decision of the Central Electricity Authority to build an atomic power station on the Severn Estuary within six miles of the Wildfowl Trust directed by Mr. Peter Scott, and another at Bradwell, on the River Blackwater, which is the wintering ground of a high proportion of the brent geese in Europe.

The threat to the proposed nature reserve in South Uist and to St. Kilda arises from the proposed Hebridean guided missiles range announced by the Government on July 27. In reply to a question in the House of Commons on October 25, the Minister of Defence stated that safety requirements demanded that a guided missiles range should be in a less populated area and also avoid congested air and shipping routes and extensively fished areas; it must also be associated with radar and airfield facilities. These considerations narrowed the choice of sites in the United Kingdom to the Outer Hebrides, and South Uist had been selected after a reconnaissance of the islands there. When specific proposals had been formulated in the light of the survey now proceeding, the interests concerned would be given the opportunity to lodge objections and a public local inquiry would be arranged if necessary.

This statement, and the subsequent debate in the House of Lords on October 27, reveal the inherent weakness of the existing procedure, under which, in effect, the Service departments are judges in their own cause, and the dilemma with which we are increasingly confronted in a small island such as Great Britain. As Lord Polworth remarked in opening the debate, the needs of defence must take first place; but he challenged the view that technical needs must have absolute priority on every occasion. There are other values in our civilization which the Services exist to defend and preserve. Pressed to an extreme, claims on land could leave us with nothing worth defending.

The scientific, as well as the cultural, interests affected by the proposal were emphasized by Viscount Elibank and by the Earl of Haddington, who referred to the importance of South Uist as a breeding ground for such rare birds in the British Isles as the red-necked phalarope and the hen harrier, and for more than half of our greyleg geese, and of St. Kilda for the Manx shearwater, Leach's petrel and puffins, as well as the archæological importance of South Uist. Lord Carrington, who replied, was content, however, rather to argue the value of a range in Britain instead of overseas than to answer either the social, cultural or scientific objections; though he acknowledged the need to preserve undisturbed as far as possible the wild life of the islands.

Lord Polworth withdrew his motion, but the particular project clearly calls for further discussion; and, if it is essential for the project to proceed, the Government would be wise to deal with the general issue in such a way as to facilitate carrying with it general consent of the country. If proposals involve not merely the disturbance of a particular community but also the destruction of an irreplaceable cultural and scientific heritage, it is important that the decision should be seen to be justified on full consideration of all that is involved and of what the scientific implications may be. Such decisions can never be easy, but too great care cannot be taken to remove all grounds for the suspicion that the judgment may have been made by some interested party without adequate regard to its implications in other fields. Public opinion remains the ultimate safeguard; but the Government could do more to promote the formation of an informed public opinion, and to remove the undoubted danger that difficult decisions of this kind may spread a wave of defeatism and disappointment that offsets much of the advantage to defence inherent in the decision.

LANGUAGE OF THE EMOTIONS

The Expression of the Emotions in Man and Animals

By Charles Darwin. Pp. xi+372+15 plates. (New York: Philosophical Library, 1955.) 6 dollars.

THE scientific study of expressive movement and action began with Sir Charles Bell's famous "Anatomy and Philosophy of Expression", first published in 1806. Important contributions from the Continent of Europe did not come until half a century later, in the work of Duchenne (1862), Gratiolet (1865) and Piderit (1867). Darwin's own studies of expression date at least from 1838, although his book was not published until 1872. Continental scholars, especially students of the origin and development of language, have shown a sustained interest in this subject; but since the work of Darwin there is little to report from Britain, perhaps

because the demeanour of the natives is less demonstrative than it is across the Channel.

Darwin's investigation is marked by the comprehensiveness of his sources as well as by an acute sensibility in detecting the finest nuances in human expression. His data consist of observations of infants, the aged, the insane, the commoner animals, photographs, and paintings and sculptures of the great masters. This is supplemented by reports on the behaviour of diverse ethnic groups and cultures obtained from thirty-six observers living in Australia, China, India, Africa and North and South America.

The origin and development of all the expressive actions in man and animal he attempts to explain by means of three principles: the principle of serviceable associated habits; the principle of antithesis; and the principle of the direct action of the nervous system on the body.

Judged by present-day standards of statistical technique, his methods of sampling and of drawing inferences would perhaps scarcely be considered adequate. We do not share his faith in "associationism". Nor would we speak of "thrills of nerve-force" or of the inheritance of tricks and gestures. Yet somehow his conclusions do not seem any the less convincing; the high quality of his initial observations appears to make up for any lack in quantitative precision. The idea that a flood of new cybernetic light would be thrown on his subject by substituting 'communication' for 'expression', as seems to be implied by Dr. Margaret Mead in her preface, is perhaps a little sanguine.

Blushing, to which Darwin devotes an entire chapter, seems to him to stand in a class apart. He regards it as the most peculiar and the most human of all expressions. We cannot cause a blush by physical means—that is, by any action on the body. The mind must be affected: "thinking what others think of us, excites our blushes". We do not expect him to accept Burgess's view that blushing was specially designed by the Creator in order "that the soul might have sovereign power of displaying in the cheeks the various internal emotions of the moral feelings". The hypothesis he prefers rests on his belief that our powers of attention can influence the capillary circulation. He cites many eminent anatomists and physiologists, including Holland, Laycock, Carpenter, Paget and Johannes Müller, in support of his view that attention or consciousness concentrated on any part of the body produces some direct physical effect on it. But he admits that the means whereby attention—"perhaps the most wonderful of all the wondrous powers of the mind"—is affected is an extremely obscure subject. How far removed he is from those who believe that consciousness and attention are nothing more than occult qualities gratuitously introduced into the palpable world of anatomical 'reality', a world in which one is at most permitted to say that "the brain makes up its mind"!

He concludes that expressive actions are in general inherited and that only a few expressive movements, such as those of the hands in prayer, are learnt. The fact that the chief expressive movements are the same throughout the world he regards as affording an argument that we are descended from a single parent-stock, which must have been almost human before the divergence of the "races".

It is to be hoped that this new edition of Darwin's work, which has not by any means yet received the study it deserves, will serve as a reminder that there is an inner life of human emotion of which actions and gestures are simply manifestations. The scientific study of emotional experience is therefore not merely the lining of physiology.

John Cohen

AMERICAN METHODS OF MATERIALS TESTING

The Testing and Inspection of Engineering Materials

By Prof. Harmer E. Davis, Prof. George Earl Troxell and Prof. Clement T. Wiskocil. (McGraw-Hill Series in Civil Engineering.) Second edition. Pp. xv+431. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 49*s*.

THE testing of materials is a fundamental necessity at some stage in all manufacturing or constructional processes. To what extent it can be treated as a particular subject for a course of instruction depends, of course, upon the educational establishment concerned. This book has been written as a text-book for such a course. The authors state in the preface that it is their aim "to provide a general treatment of the principles and problems of testing with specific reference to the mechanical properties of engineering materials and to establish the basis for the inspection of these materials". As such, it is a good review of mechanical testing in a wide form and has a very comprehensive reference list. It is written for Americans and refers entirely to standard specifications in the United States; hence there are limitations on its usefulness in Great Britain.

Two introductory chapters deal with the nature of the problem and the general features of mechanical testing. In Chapter 2, one is immediately struck by the difference in American and British practice by the use of 'yield strength' instead of the synonymous 'proof stress'. Chapter 3 covers load and strain measurement and inspection gauges. A notable omission in the otherwise comprehensive survey of strain gauges is the vibrating wire gauge.

Static (that is, tensile, compressive, etc.) tests are covered in great detail in the next two chapters, and hardness tests in Chapter 6. The Vickers diamond-pyramid hardness test, however, receives only half a page. Chapter 7 deals with impact tests and has certainly been brought up to date by reference to recent work on the dependence on temperature of notch brittleness of steels.

Fatigue and creep are the subjects of Chapter 8, but are covered very briefly compared with previous subjects, having only twenty-four pages devoted to them. On p. 220 the authors state the well-known fact that duralumin does not show a well-defined endurance limit, but then quote a value for it on p. 221. Non-destructive methods of flaw testing are outlined in Chapter 9 and include visual, X-ray, γ-ray, magnetic, electric and ultrasonic methods. Chapter 10 is a useful chapter on analysis and presentation of data and mainly deals with elementary statistics of observation. Chapter 11, entitled "The Principles of Inspection", deals with the organizational aspect of the problem and is concerned with the inspector, his qualifications, duties and responsibilities.

Part 2 is a section on laboratory work in testing and inspection, and outlines a series of twenty-four

exercises that would make a suitable course. The appendixes include a brief summary of the principal mechanical properties of the more-important metals and non-metallic constructional materials. The book would form a good guide to a technical college course on mechanical testing, but would not be suitable in a university curriculum except as a reference book to American methods. K. J. PASCOE

DETERGENTS IN THE FACTORY

Industrial Detergency

Edited by Wm. W. Niven, Jr. Pp. iv+340. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1955.) 70*s*. net.

CLEANING is an operation widely employed in industry. As the introduction to this book points out, it may constitute the major basis of the industry as in laundering; it may be an inherent part of the process by which the finished product is made, as in metal plating; it may safeguard the quality of the finished product, as in the food industry; or it may add to general efficiency, as in plant maintenance. Great technological advances have been made during recent years, and the declared aim of the book is to give a comprehensive treatment of industrial detergency, a subject to which few books have been devoted in their entirety.

A very brief chapter is entitled "The Fundamentals of Detergency". The author admits that this may be a misnomer and that no attempt has been made to discuss the physical chemistry of detergent systems. Other texts need to be studied to obtain a proper understanding of the subject. The chapter on detergent materials is more adequate. Evidence is given to rebut a commonly held belief that the action of synthetic detergents is unaffected by water hardness, and it is emphasized that not all surface-active compounds are detergents. Examples of commercial products are restricted mainly to those of American manufacture.

All cleaning operations must be designed according to the characteristics of the substrate being cleaned, and therefore classification according to industry has been adopted, seven authors contributing to this section of the book. Because of this, some overlapping has occurred, for example, in the chapters on detergent materials and the laundry industry. The latter chapter deals almost exclusively with practice in the United States. The advantages of including a controlled amount of water in dry-cleaning baths are becoming more and more appreciated, and some discussion is given of the theory underlying this addition, although I do not agree that dirt redeposition is adversely affected by the presence of limited amounts of adsorbed moisture on wool in certain detergent systems.

Subsequent chapters deal with detergency in the textile and food industries. Little is known of the effect on man of the ingestion of small quantities of detergents over a prolonged period, and it is therefore appropriate to emphasize the importance of thoroughly rinsing away detergents, so that subsequent contamination of foodstuffs prepared in plant cleaned by them does not occur. Much that is said in the individual chapters on foods and beverages, the dairy industry and dish-washing applies equally to all these applications and could more conveniently have been dealt with under one main heading. The final chapters are devoted to the metals industries and to general industrial cleaning, which covers a range of applications from simple floor-cleaning to the complex treatment of aircraft.

One of the problems in any application of detergents is the selection of those products which are most suitable for the purpose. The evaluation of detergents is not dealt with for every application described in the book, and although the information is available elsewhere, its inclusion would be appropriate in a comprehensive manual of this nature. Nevertheless, the book contains a great deal of useful information concerning American methods in a wide range of cleaning processes. R. E. WAGG

ORGANIC REACTIONS

Organic Reactions

Edited by Roger Adams, A. H. Blatt, Arthur C. Cope, David Y. Curtin, Frank C. McGrew and Carl Niemann. Vol. 7; pp. viii+440; 72*s*. net. Vol. 8; pp. viii+437; 96*s*. net.
(New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953–54.)

EACH of the volumes in this series consists of a number of chapters, dealing severally with a single reaction capable of wide application, or sometimes even with a particular phase of such a reaction. The series was begun in 1942, and from its inception it has progressed under the wise direction of Prof. Roger Adams as editor-in-chief, assisted by changing teams of skilled and experienced collaborators.

These successive volumes provide a welcome aid to the practising organic chemist, having his habitation in these latter days in the midst of a deep and rapid river of literature which threatens to rise and engulf him. The life-line of "Beilstein" and similar publications so often falls short of his needs that supplementary devices have become essential if he is to keep his head above water. In other words, the practitioner of organic chemistry needs something that will enable him to make a quick, comprehensive and up-to-date survey of the current position in his particular field of work. "Organic Reactions" renders this kind of service by assembling the requisite information under the heads of specific reactions of outstanding importance, thereby bringing about a dissection of a vast body of published material into manageable units. Experience has shown the great practical value of this method of classification, although, of course, it cannot be claimed to meet every need.

The limited goal of each chapter renders possible a surprisingly thorough coverage of the material and publications concerned. Chapter 6 in Vol. 8, on the metalation reactions with organolithium compounds, may be taken as a typical example. A section of forty-seven pages includes an introduction followed by concise accounts of the mechanism and scope of the reaction. Other types of metalating agents are then mentioned; and details of experimental conditions and procedures are followed by a tabulated summary of such reactions to be found in the literature up to the end of 1952, the yield and literature reference for each of a couple of hundred compounds being given. The seven chapters of Vol. 7 include, among others, the Pechmann reaction, the Skraup synthesis, the von Braun cyanogen

bromide reaction, and the epoxidation and hydroxylation of ethylenic compounds with organic peracids. Vol. 8 contains eight chapters, including catalytic hydrogenation of esters to alcohols, the Sommelet reaction, the metalation reaction with organolithium compounds, and β-lactones.

Some of the cathedrals and other noble buildings in Britain enjoy partial relief from their burdens through the activities of associations of 'friends': Prof. Adams and his collaborators, fulfilling a similar beneficent function for molecular edifices, might well be hailed as 'friends of organic chemistry'.

John Read

NEW METHODS OF SCHOOL TEACHING IN AUSTRALIA

Teacher, Pupil, and Task

Elements of Social Psychology applied to Education. Edited by O. A. Oeser. Pp. xiii+196. (London: Tavistock Publications, Ltd., 1955.) 18*s*. net.

In 1953 a refresher course for teachers, carried out by the method of group discussion, was held at the University of Melbourne, and fourteen contributors to this book, all of them teachers in the University or in training colleges, were leaders of these discussions and have prepared the book in response to a demand by the teachers for a reference manual. The editor, O. A. Oeser, who also contributes two chapters, is professor of psychology at Melbourne.

It would seem that the teachers might have profited by a longer and more thorough treatment of the topics discussed—although suggestions are given for further reading. As it is, the separate sections of the book differ considerably in method of treatment, and in general satisfactoriness. The chapters on testing and on examinations are simple and straightforward; but they are not sufficiently detailed, and neither is that on vocational and educational guidance. The chapter on 'the problem child' is as adequate as is possible in covering such a complex subject in a small space.

But the most interesting and most controversial part of the book deals with the promotion of good social relations between staff and pupils, and of the pupils with each other. It is recommended that the natural social affinities of the children should be assessed by Moreno's sociometric technique; that classes should be divided up into small groups, on the basis of these affinities and of similar ability; and that the groups should carry out their school work as a group activity, with the teacher suggesting and guiding rather than giving direct instruction. Now the suggested method undoubtedly offers points of great interest; and it seems possible that it does promote highly desirable easy and friendly social relations. It is also claimed to make the children more active and more interested, and to stimulate them to work better. But little evidence is available to substantiate this claim.

It seems unlikely that the more intelligent children would profit by these methods in studying the more arduous and difficult subjects. Indeed, the result might be to produce the type of individual described in American society by David Riesman in "The Lonely Crowd": the individual whose sole purpose it is to get on well with others, to adapt his behaviour flexibly to his society, and to do what is expected of him by others. Perhaps the authors have no such intention. But it would be disastrous if such procedures were adopted uncritically, without further experimental test, to the neglect of the intelligent and highly individualistic child, whose particular interests and initiative require individual encouragement and strenuous adult teaching.

SOCIAL ANALYSIS OF LIFE IN A MENTAL HOSPITAL

The Mental Hospital

A Study of Institutional Participation in Psychiatric Illness and Treatment. By Dr. Alfred H. Stanton and Dr. Morris S. Schwartz. Pp. xx+492. (London: Tavistock Publications, Ltd., 1954.) 35*s*. net.

During the past ten years American sociologists and social psychologists have shown great interest in the analysis of subordinate institutions within their society and, in particular, in studies of prison and of mental-hospital communities. This focus of attention has been influenced no doubt by contemporary events, which have directed attention to the overcrowded State prisons and State hospitals as social problems of some urgency. In the latter case, the quickening of theoretical interest has been due in no small measure to a series of papers by A. H. Stanton and M. S. Schwartz which began to appear in 1949. The three-year study of the functioning of a mental-hospital ward, on which these reports were based, is the subject of this book.

If there is one generalization which can be safely made about any human institution, it is that it is not perfect. Social analysts, like psycho-analysts, find it easier to recognize failures of function than to do justice to systems which work smoothly. The great merit of this work is that it subjects to careful scrutiny all those aspects of mental-hospital life (such as the formal administration, the daily interactions among patients and between patients and personnel) which tend to be taken for granted and ignored. In repeated instances, the authors have demonstrated that patients' illnesses can be aggravated or relieved in response to events occurring in this social penumbra. Their discoveries are often too true to be altogether welcome. Already they have provoked reactions from incensed administrative psychiatrists; but the data and their interpretations remain, to be confirmed or modified by other social scientists.

Two criticisms may legitimately be directed against this work. First, it is disappointing that original explanatory concepts are so rare; most are derived from established inter-personal theory, and the most original of all (the effect upon a patient's mental state of covert disagreement between two of those in charge of him) now appears to be attributable to previous observations by Suzurek. Secondly, with some notable exceptions, there are all too few instances where the *verstehende* concept (an intellectually satisfying explanation) has been confirmed by systematic, statistically significant, observations. This defect is in part a measure of the pioneering quality of the authors' work, and can be remedied. A valuable section of the book, which will interest everyone concerned with mental-hospital practice, is the review of recent sociological studies in this field.

G. M. Carstairs

ORGANIZATION OF DEFENCE RESEARCH IN BRITAIN

By CHAPMAN PINCHER

THE organization of defence planning in Britain has undergone a revolution since the beginning of the Second World War. Whereas scientists were previously regarded with some suspicion by fighting men as being usually impracticable dreamers, defensive planning is now dominated by scientific thought and methods.

This change would have been inevitable following the emergence of nuclear bombs, guided missiles and other extremely intricate devices; but Britain got off to a good start in post-war defensive thinking because the formulation of policy was already being guided by scientists. This was largely due to the efforts of a few pioneers like Sir Henry Tizard, whose foresight resulted in such war-winning devices as radar.

The present system dates from the establishment of the Defence Research Policy Committee under Tizard in 1946. This Committee dominates the picture and must be considered in some detail.

The Committee is responsible to the Minister of Defence. It consists of fourteen men, the permanent chairman, the Deputy Chief of Naval Staff, Deputy Chief of the Imperial General Staff, Deputy Chief of Air Staff, Deputy Controller (Research and Development) Admiralty, Scientific Adviser to the Army Council, Scientific Adviser to the Air Ministry, Chief of the Royal Naval Scientific Service, Chief Scientist of the Ministry of Supply, Controller of the Navy, Controller of Supplies (Munitions) Ministry of Supply, Controller of Supplies (Air) Ministry of Supply, Controller of Guided Weapons and Electronics, Ministry of Supply, and Secretary of the Department of Scientific and Industrial Research (see p. 260).

A special subcommittee deals with atomic matters and co-opts experts such as Sir William Penney. Special *ad hoc* panels are occasionally set up to take advantage of specialist brains in the universities and in industry.

Since August 1954 the chairman has been Sir Frederick Brundrett, who previously served as deputy to Sir Henry Tizard. Sir Frederick is also scientific adviser to the Minister of Defence and with the additional influence of membership of several other committees is currently the commanding figure in the defence research field.

The Defence Research Policy Committee is purely advisory and has no executive powers; but once its conclusions are approved by the Chiefs of Staff and Minister of Defence, they cannot be changed without the Committee's further agreement.

The cycle of events begins with the formulation of weapons *requirements* by the Chiefs of the separate Services. The Service officers who are responsible for the formulation of requirements are the Deputy Chiefs who are members of the Committee. At this stage these men have a general idea of the performance they want in new weapons and are guided in keeping the requirements within the bounds of practicability by the individual scientific advisers attached to their staffs. It will be noticed that the scientific advisers to the Army Council, Air Ministry and Admiralty (the Deputy Controller (Research and Development)) also figure on the Defence Research Policy Committee.

The Staff requirements are then passed to the Controllers in the Supply Ministry, in the case of the Army, Royal Air Force and Naval Air Services. The general Naval requirements are passed to the Controller Admiralty. (Again it will be seen that these four men also sit on the Defence Research Policy Committee.)

In the Ministry of Supply and Admiralty scientists examine the research and development problems raised by the requirements to consider how they can be met with available resources. They study the questions of man-power, materials, research equipment and techniques. Their considered opinion then goes back to the Service Chiefs who originally formulated the requirements.

It is at this stage that the requirements, by this time usually modified in the light of the opinions already passed to them, are considered by the Defence Research Policy Committee, which it will be seen contains the officers in the several departments who hold executive responsibility for the various aspects of the work. The Committee's prime function is to ensure that the whole defence programme is kept within the limits of the country's resources and finance and that there is no unnecessary overlapping of research effort between the Services. The Service demands are invariably well in excess of possibilities, and the Defence Research Policy Committee does the pruning.

The Committee normally meets once a fortnight. The agenda has been fixed and there is a firm rule that the members must have been notified at least a week in advance of every item to be discussed. This means that the members have had ample time to consider the subjects before the meeting begins.

To do its preliminary work the Committee has a small staff which is carefully selected both from the point of view of ability and security.

There is a full-time staff consisting of a Forces representative and a scientist from each Service with an administrative under-secretary from the Defence Ministry. The Defence Research Policy Committee appoints a scientist to act as the chairman of this full-time staff annually.

In addition there is a part-time staff which is entirely scientific consisting of one representative from each Service, the Ministry of Supply and the Naval Scientific Service. These men remain in their normal posts but devote about half their time to Defence Research Policy Committee work.

The men chosen for these staffs must have special aptitude for viewing the nation's defence problems as a whole without being unduly biased by loyalty to their particular Service.

The Defence Research Policy Committee gets guidance on strategic policy in the form of directives from the Staff Chiefs and the Minister of Defence, which enable it to assign inter-service priorities for those requirements and projects which are considered feasible.

These priorities are, of course, in general terms. Final decisions on precise priorities in individual experimental establishments must necessarily be taken by the supply Ministries, which know the day-to-day situation concerning facilities.

When agreement has been reached by the Defence Research Policy Committee and the resulting programme approved by the Chiefs of Staff and Minister of Defence, executive action is put in hand by the Ministry of Supply or the Admiralty. The work is then begun at one of the Government experimental establishments, or is farmed out to industry.

These Government establishments are numerous and employ several thousand scientists and engineers. Among the best known are the Royal Aircraft Establishment at Farnborough, Hants, the Telecommunications Research Establishments, Malvern, the Fighting Vehicles Establishment at Chobham, the Microbiological Research Department and Chemical Defence Research Establishment at Porton, the Admiralty Signal and Radar Establishment at Portsmouth, and the Admiralty Research Laboratory at Teddington. Atomic weapons research requirements are passed from the Ministry of Supply to the Atomic Weapons Research Establishments of the Atomic Energy Authority at Aldermaston, Berks.

Many industrial firms have set up substantial departments and in some cases entire factories for defence research and development.

Through its staff which visits the experimental establishments and industrial concerns involved, the Defence Research Policy Committee is kept informed on how projects are progressing. From time to time projects have to be modified or occasionally scrapped because they are not working out according to plan, have been made obsolete by events or for economy reasons.

The duties of the Committee so far described deal with clear-cut applied research. There is a special Research Sub-committee which concerns itself to ensure that the more nearly fundamental research for defence purposes carried out in Government establishments is kept on what appear to be the most profitable lines. Clearly even in fundamental research carried out with public funds, limits have to be set much more closely than in the universities.

It will be seen that the Committee does not usually initiate projects, but functions mainly by modifying the proposals of others. Nevertheless, it does exert considerable influence on future projects through its annual report called the Defence Research Policy Review, which is, of course, a highly secret document. The first part of the review is a progress report, but Part 2 is a "Way Ahead" section dealing with future requirements.

For such wide strategic surveys the Committee needs to be informed on some aspects of foreign weapons developments. This information is supplied by the Staff working in the Defence Ministry which controls the Joint Intelligence Bureau (see *Nature* of March 26, 1955).

The Committee looks into special fields two or three times a year to produce detailed reports on such subjects as guided missiles, radar, and signals communications. It also examines and co-ordinates draft annual estimates on research and development submitted to the Ministry of Defence by the Admiralty and Ministry of Supply.

The views of the Committee are continually made known to the Cabinet by the Defence Minister, who is kept advised of the Committee's activities through the chairman. As pointed out in *Nature* of January 7, p. 18, the Defence Minister has been given responsibility for framing general policy governing research and development. In this connexion he relies heavily on the chairman of the Defence Research Policy Committee, who is also his personal scientific adviser.

Not only is the chairman in constant touch with the Defence Minister but he is also occasionally invited to sit in at meetings of the Cabinet's Defence Committee. In addition, he is in regular touch with the Chiefs of Staff and frequently attends meetings of their Committee, which now has a permanent chairman (Sir William Dickson) based in the Ministry of Defence.

Thus the chairman of the Defence Research Policy Committee is able to ensure that its members are in turn kept aware of the Government policy which must overshadow all defence planning.

AUTOMATIC CONTROL IN THE PROCESS INDUSTRIES

MUCH attention has been directed recently to the potentialities of automatic control as a means of increasing industrial efficiency, particularly by the use of electronic measuring and control equipment and, above all, by employing electronic computers. Rapid advance towards the completely automatic factory has been predicted and serious misgivings have been raised about the social consequences of employing more and more automatic equipment in place of men to control factory operations.

Consideration of the completely automatic factory and its implications for society as a whole can, however, safely be confined for the time being to the light engineering industries, in which the mass production of components is carried out by machines on a production line. The automatic control of such production lines has already been highly developed in specific cases and will, no doubt, be extended rapidly in the near future. In the process industries, however, a completely automatic factory is still a long way off and, if it ever comes into existence at all, it will be based on a steady evolution of technique rather than on spectacular revolutionary advances. Individual sections of, say, oil refineries or chemical works are at present automatically controlled to a large extent. They could not in many instances be successfully operated without their automatic control systems; but on the other hand they still demand the presence of human operators to reset the automatic controllers to meet the needs of changing conditions.

The process industries have been steadily developing and applying automatic control over the past thirty years, and the number of operators employed is consequently already small. Economies in operation, due to improved automatic control systems, will not result in general from the decrease of this small number of operators but rather from improved efficiency of operation. The problems to be overcome in the further development of automatic control in the process industries are, therefore, purely

technical and unlikely to involve questions arising from redundancy of operators.

The object of the very considerable amount of research and development being carried out in the field of process control is to make available the full potential of automatic control to decrease production costs. This object can only be achieved by taking account of the requirements of the control system when the process and plant are being designed. To do this, the designer must be able to calculate the characteristics of the process and plant, and to predict the effect of modifications to their design on all aspects of operation—including control. This must require a quantitative knowledge of those characteristics of process and plant which determine their controllability.

It is self-evident that when a control system has to take action, it must either correct a disturbance in conditions or effect a desired change in them. Thus, to design and adjust a control system it is necessary to know how the plant and process respond to changing conditions; that is to say, it is necessary to know the 'dynamic' characteristics of plant and process as well as their characteristics in steady conditions.

The development of automatic control techniques in the process industries has been very severely hampered by lack of knowledge of these dynamic characteristics. Until they can be calculated, control systems cannot be designed quantitatively. In related fields, such as the design of electrical amplifiers or of servo-systems to control machines, a much more quantitative approach to control system design is possible because the dynamic characteristics of the controlled system itself can be calculated with much more accuracy.

Since 1946 there has been a noticeably increasing emphasis, in the papers written on process control, on the necessity for studying the dynamic characteristics of processes and plant, and for enlisting the assistance of all concerned with their design and operation in obtaining the data required, by experiments on the factory.

The engineers responsible for the development and design of processes, and the engineers responsible for the design of their control systems, have a common interest in obtaining these data and in collaborating to develop the technique of process control system design. They must also collaborate closely with those responsible for operating process plant, on which the necessary experiments to obtain data must be carried out. The plant designer, who is often a chemical engineer, must play a vital part because he will have the responsibility of incorporating in the plant the design features which these investigations will show to be desirable for improving controllability.

The importance of close collaboration between the engineers concerned with the design and operation of processes and plants and the control system designers has been stressed repeatedly during the past few years. The most recent and authoritative statement on this subject was made by Sir Harold Hartley in April 1955, in his presidential address to the Institution of Chemical Engineers. In this address the problem is clearly stated as follows:

"In the chemical and process industries, the whole tendency is towards continuous plants with the economies they offer in capital cost, man-power and throughput—whenever the volume of production is sufficiently great. Such continuous plants have demanded a large amount of instrumentation and automatic control and one of the main purposes of a pilot plant is to investigate the instrumentation required. In many cases the plants have been designed and the instruments and control added later, and in fact all processes are really manually controlled because every major load change in general requires re-setting of the desired values of all the controls. Electronic devices are much quicker and more accurate than the human senses, and with appropriate servo-mechanisms they offer great advantages. With the rapid advances in the design of automatic controls, design engineers have been able to make considerable improvements by the incorporation of the latest standard instruments as they come on the market. Recently this approach to the process design problem, the addition of controls to process flow sheets, has reached something of a stalemate. It is now clear that the major advances will only be achieved if the use of automatic control is considered in the earliest design stages. This means that there must be consultations between the chemical engineer and the automatic control engineer from the earliest stages and a sympathetic understanding between them.

"We must move on from the stage of adding process controls in an empirical manner. This is not an easy matter, however, and it will call for a basically new approach to the problem of process design. Two difficulties appear to stand out. First there is a grave shortage of automatic control engineers with the necessary experience. Coupled with this is the shortage of chemical engineers with sufficient understanding of the theoretical approach to automatic control. Secondly, there is an almost complete lack of the information on plant and process characteristics which is required to enable automatic controls to be applied in a scientific way. Thus we have to face a dual problem of education and training on the one side and lack of quantitative data on the other."

Some six months earlier, Sir Harold had proposed a joint conference between the Institution of Chemical Engineers and the Society of Instrument Technology—the membership of which includes the majority of those actively interested in developing and applying automatic control in the process industries. This proposal was welcomed by the Institution and the Society alike as a means of attacking the "dual problem of education . . . and lack of quantitative data".

The need for the conference was very clearly demonstrated by the attendance of about eight hundred engineers, physicists and mathematicians at Church House, Westminster, on October 4, when the proposed conference was held. Both the size of the attendance and the very representative cross-section of engineering interests it represented afforded clear proof of the interest in the subject of discussion, namely, "Automatic Control in the Process Industries".

The first object of the Conference was defined in the following words by Mr. John Oriel, president of the Institution of Chemical Engineers, in his opening address. "The time has passed when instrumentation could be looked upon as a luxury; nowadays, with much of our plant designed for continuous operation, often with high throughput and with very severe operating conditions, the control is an essential part of the process itself, and the design of the plant is incomplete unless full account has been taken of the instrumentation. The need, therefore, for the closest collaboration between the instrument technologist

and the chemical engineer during the design, development and operation stages is of the greatest importance. The need for a complete understanding of each other's problems cannot be over-estimated." Mr. Oriel thus placed the emphasis firmly on the need for close collaboration between those who develop and design control systems and those who develop and design processes and plant, and the necessary basis for such collaboration is stated unambiguously; namely, "a complete understanding of each other's problems".

The Conference was therefore essentially educative and the papers were carefully arranged to give as concisely as possible, and in the simplest terms, the basic information required by the chemical engineer to enable him to appreciate the requirements of the control system when designing processes and plants, and the necessity of carrying out investigations on full-scale plant in order to obtain information about the mechanism governing its behaviour as part of the control system.

It may well be asked at this stage why the chemical engineer has not become familiar with the basic principles of automatic control during his academic training, and why he cannot supply the information about his processes and plants which is required by the control system designer. These two questions must therefore be answered; but first it must be emphasized that the real significance and importance of this Conference rests on the fact that it marks the recognition of the problem which the questions pose, and represents the first step in a combined attempt by the plant designers and control system designers to solve it.

Education of the Chemical Engineer in Control System Design

The education of the chemical engineer is not complete unless he has a knowledge of the basic principles underlying the proper application of instrumentation and automatic control to industrial processes and plant, because, as has been stated already, their design and their method of operation have become (and will become increasingly) dependent for their economic success on their controllability. The universities and technical colleges have recognized the desirability of providing the chemical engineer with a knowledge of these basic principles, and the chemical engineering departments of several universities have made a generous allowance in their teaching programmes for a study of control systems. The very wide field to be covered in a chemical engineering syllabus makes this difficult to do; and it has been found possible to do it only in those schools which have appreciated the vital importance of the subject and are prepared to sacrifice something else for it. Many even of the younger chemical engineering graduates have had little opportunity, therefore, of studying the subject during their undergraduate years, and it was for these graduates and for those who graduated before instrumentation had achieved the general appreciation it now enjoys that the Conference was arranged.

As time goes on, and the inclusion of substantial courses on automatic control in graduate engineering syllabuses becomes more general, the need for joint conferences of plant and process designers and control system designers will certainly increase. Future conferences will not be primarily educative as in the case of this first conference; they will be pitched at an increasingly advanced technical level and will be concerned with the discussion of system design problems.

Chemical Engineering Data

The available chemical engineering data, although not as accurate as is sometimes desirable, are in general adequate to permit the prediction of process and plant behaviour in steady conditions and, therefore, to permit the economic design of plant to give a specified output of a given product of the required quality—as long as there are no major disturbances to the operating conditions. It is, of course, the object of a control system to eliminate such disturbances or to minimize their effect on operation; but it will be clear that if they are to do so most effectively, the dynamic characteristics of the process and of the plant must be designed to make the task as easy as possible. Such design, however, demands a knowledge of the mechanism governing these characteristics, and since this mechanism has not been of immediate concern to the plant designer in his main activity of designing for a steady output, he cannot be blamed for not having studied it. In future, however, he must. The essential basis for such study was presented very concisely and simply in the first two papers presented at the Conference.

It is not proposed to give a summary of these and other papers presented at the Conference and the discussion upon them because they have been published in full in the *Journal of the Institution of Chemical Engineers*.

Economics

It is of interest, however, to record the very significant fact that in every paper, including the opening address by the president of the Institution and the concluding remarks by Sir Harold Hartley, past president of the Institution, and by the president of the Society of Instrument Technology, the economic aspect of control system design was emphasized. Even in the first paper dealing with fundamental principles, Mr. R. S. Medlock pointed out that the design of a control system depends on the economics of the process, and increasing emphasis was placed on the economic aspect of the problem by each succeeding paper until the last paper but one, by Mr. S. W. J. Wallis, which was devoted entirely to the economics of process control.

This emphasis on the economics of the matter reflects the growing consciousness of control engineers of their responsibility for developing, and applying to the full, the potential of automatic process control as a means of reducing production costs.

The gradual evolution of process control to its present high standard of performance has been so continuous that, to a large extent, its contribution to reduction of process operating costs has been masked. Mr. G. C. Eltenton, in opening the discussion at the afternoon session, was voicing the conviction of the process control engineers themselves, when he pointed out the value of being able to give firm facts to demonstrate the reduction in production costs which automatic control has effected in specific instances. Unfortunately, it is very rarely that it has been possible to obtain the firm figures which are unanimously agreed to be so desirable, and Mr. Eltenton's remarks presented a challenge to both control and chemical engineers which they must take up. This will result in the production of new figures on the economics of process operation, and these will

be of the very greatest importance to the subject—not only as a means of extending the use of automatic control in the process industries, but also as a means of improving the design of process control systems and of process plant as a whole.

Organization

Two other very important matters were raised during the Conference; both concerned organization, in different ways. The first concerned the methods of organizing the design of processes and plant in order to bring to bear on the problem the full knowledge available to both the chemical engineer and the control engineer. In opening the discussion following the morning session, Mr. J. E. Braham directed attention to the difficulties involved in this problem, and to the necessity of giving thought to their solution at the present time. Clearly this is very necessary, because much delay will occur in the application of new design practices unless the process industries have built up design organizations of the proper nature to deal with them.

The organizational problem associated with the new conception of combined design by the chemical engineer and the control engineer had received too little previous consideration to permit any immediate discussion at the Conference, but there is no doubt that Mr. Braham's timely warning of the difficulties to be overcome will be the subject of considerable attention in the near future.

The second organizational problem arises from the necessity of building up a fund of experimental data on plant and process characteristics. These data should clearly be collected and correlated, as Mr. Oriel pointed out in his opening address, by some central body "where there can be a ready exchange of data which is so urgently needed" by both the plant designer and the control designer.

Sir Harold Hartley, in his summing up of the Conference, suggested that this might well be a function of the National Chemical Engineering Research Station, which it was recommended by the Cremer Report should be set up and sponsored jointly by the Government and industry. Some delay, however, is unavoidable before any new organization could undertake this responsibility, and it was suggested by the president of the Society of Instrument Technology that the Control Section of the Society could well undertake this important work in the meantime. By doing so, the Society could avoid the delay which might otherwise occur in organizing the collection and correlation of the data and could make a valuable contribution to accelerating progress in this field and thereby decrease the production costs of the process industries.

It is clear, however, that the success of any central organization employed for collecting and correlating technical data, or of any organization in individual companies for putting into design practice the new techniques envisaged, must depend on the close collaboration of process plant and control system designers. The most important result of this Conference has been to stimulate a joint approach to the problem and care must be taken in the future to encourage and preserve it.

AGOSTINO BASSI, 1773–1856

By Dr. G. C. AINSWORTH
Department of Botany, University of Exeter

THE concept of pathogenicity is now so familiar that it seems scarcely possible that less than a century ago the question of the reality of microbial infections could still be a living issue. The controversy which then prevailed was, however, at least for pathogenic fungi, becoming a rearguard action by the few who were unable to appreciate the significance of discoveries made between 1835 and 1846 by an Italian lawyer turned farmer, by a Hungarian medical man in Paris, and by an English country clergyman—microbiologists then, as now, being drawn from diverse disciplines.

The Rev. Miles Joseph Berkeley's classical paper of 1846 [1], "Observations, botanical and physiological, on the potato murrain", in which he concluded of potato blight that "the decay is the consequence of the presence of the mould and not the mould of the decay", has long been accepted as a landmark in the history of plant pathology. David Gruby's series of six short papers[2] published between 1841 and 1843, in which he elucidated the mycotic nature of thrush and the principal types of ringworm in man, is generally recognized to have laid a firm foundation for the development of medical mycology. Agostino Bassi (Fig. 1), the centenary of whose death falls on February 15, who was the first to elucidate the etiology of a contagious microbial disease and to effect the experimental infection of one living organism by another, has, on the other hand, been neglected outside his native country. He receives a few words in most histories of biology but he has been largely forgotten, even by mycologists who have perpetuated his name in the specific epithet of one of the common entomogenous fungi.

Agostino Bassi's life was uneventful and can be quickly summarized. He was born in Lombardy on September 23, 1773, at Mairago, four miles from Lodi, where he went to school. Then he studied law at the University of Pavia and after graduating in 1798 was appointed to the post of provincial administrator and assessor at Lodi, later becoming an official under the new Napoleonic regime. Like so many men of genius, Bassi suffered from life-long ill health. Defective eyesight forced him to relinquish office and to retire to his father's farm at Mairago, and one result of this was the publication in 1812 of his first book, "Il pastore bene istruito" ("The Well-educated Shepherd"), a comprehensive work of 460 pages on sheep farming. In 1815 an improvement in his health allowed him to re-enter government service, but only for a year, after which he returned to Mairago, where he devoted himself to agricultural and scientific pursuits until his death in 1856. At first financially embarrassed, Bassi in 1838 inherited a fortune from a cousin, a poor tailor of Mairago who became a wealthy military contractor and was created Count of Sommariva by Napoleon.

Bassi's interests were wide, and, while at the university, in addition to his legal studies, he took courses on mathematics, medicine and various aspects

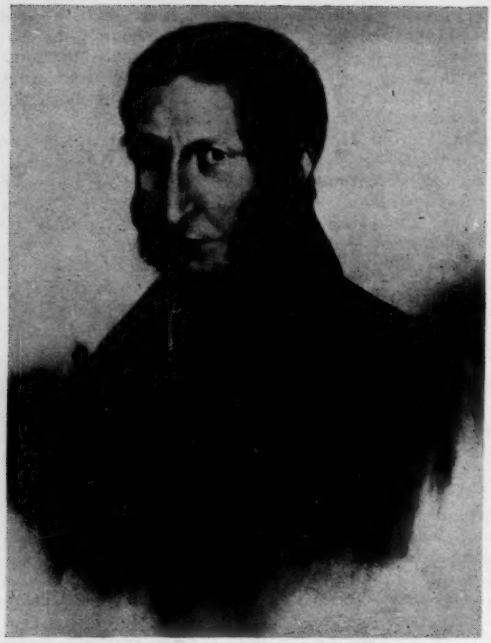


Fig. 1. Agostino Bassi (1773–1856)

of natural science, his teachers including the anatomist Scarpa, the physicist Volta, and Lazzaro Spallanzani[3] (1729–99), the versatile physiologist noted for his studies on spontaneous generation which antedated by a century those by Pasteur and Tyndall. Bassi was also of an inquiring turn of mind and in 1807 he decided to investigate the dread muscardine disease of silkworms which ravaged the silkworm industries of Italy and France. The notion prevailed that the cause of muscardine was 'environmental', that is, was due to the state of the atmosphere, the food, or the method of breeding, and it was to these aspects that Bassi first turned his attention. He "bred silkworms in all ways, subjecting them even to the most barbarous treatment; the poor creatures died by thousands and in a thousand ways", but not a single case of muscardine disease resulted. He next tested the hypothesis that the disease was due to hyperacidity and studied the effects of phosphoric acid, but although the silkworms again died there was only putrefaction; no hardening of the corpse and no white bloom on its surface, the characteristic post-mortem signs of muscardine disease. Bassi was able to simulate death by muscardine disease by hanging up silkworms enclosed in paper bags in a chimney over a continuous fire and then placing the hardened corpses in a cellar or keeping them moistened with water. Silkworms so treated deceived the experts, but to Bassi's chagrin they lacked the one essential character of a silkworm which has died from muscardine disease. The "contagious faculty" was missing. They did not induce the disease when placed among healthy silkworms.

Discouraged by his failure, Bassi was "humiliated in the extreme, silent and idle" and "oppressed by a terrible melancholy" for many months; but in 1816 his spirits revived and he began work again on a new line of attack suggested by his observations on the course of natural epidemic outbreaks. It occurred to him that the disease did not originate spontaneously but was caused by an "extraneous germ". He soon discovered that the infectious material was the white efflorescence which developed on the dead silkworms, and by subjecting this material to microscopic examination (Bassi possessed a compound microscope which after his death was acquired by the town of Lodi; Berkeley worked with doublets until 1868), he found it to be "a plant of the cryptogamic kind, a parasitic fungus". By a long series of comprehensive and often elegant experiments Bassi was able to demonstrate that this fungus was the pathogen. He showed that silkworms of all ages were susceptible and that an infected worm became infectious only after "calcination"—the sporulation of the fungus over the surface of the dead larva—and he concluded that every "spontaneous" outbreak of the disease could be traced to the introduction of infected silkworms or to the use of contaminated cages or utensils. He also developed measures by which the disease could be controlled.

By 1833 Bassi felt ready to submit his work for adjudication by the University of Pavia, and in 1834 he performed a series of the crucial experiments before a commission of nine professors from the Faculties of Medicine and Philosophy. The professors were convinced. They issued Bassi with a signed certificate which he printed in the preface of the first part of the monograph ("Del Mal del Segno, Calcinaccio o Moscardino"; Parte Prima: "Teoria", 1835; Parte Seconda: "Pratica", 1836) (Fig. 2) in which he gave a detailed account of his investigations

DEL MAL DEL SEGNO

CALCINACCIO o MOSCARDINO

Malattia che affligge

I BACHI DA SETA

E SUL MODO

DI LIBERARNE LE BIGATTAJE

ANCHE LA PIÙ INFESTATE

Opera

DEL DOTTORE AGOSTINO BASSI

DI LODI

la quale oltre a contenere molti utili precetti intorno al miglior governo dei Filugelli, tratta altresì della Malattia

DEL MEGRONE E DEL GIALLUME

LODI

DALLA TIPOGRAFIA ORCESI

1835

Fig. 2. Title-page of "Del Mal del Segno" (1835)

and his conclusions. This work aroused much interest but was given a mixed reception. Giuseppe Balsamo Crivelli, professor of natural history in the University of Milan, studied the causal fungus and named it *Botrytis bassiana* (now *Beauveria bassiana*), and confirmation of Bassi's findings was published in 1838 by the director of the Paris Natural History Museum, Victor Audouin, to whom Bassi had sent a copy of his monograph and an infected chrysalis. There were opponents, to whose opinions Bassi was perhaps unduly sensitive, but his results were well founded and convinced the unprejudiced.

The study of muscardine disease is Bassi's major achievement. In the years that followed, he issued a second edition of "Del Mal del Segno" (1837) and published additional observations on this disease. He also wrote lengthily on pellagra and cholera, on diseases of the mulberry, vine and potato, and on other topics. He received a number of honours from both Italian and foreign academies, and to commemorate the centenary of Pasteur's birth a collected edition[4] of Bassi's writings was published in Italy in 1925 under the auspices of a national committee headed by Mussolini. The collected writings are supplemented by biographical data and by a bibliography which lists more than forty articles, all in Italian, bearing on Bassi's life and work. The most important account of Bassi in English is that by Major[5].

As with many other outstanding figures in the history of science, Bassi crystallized ideas which were becoming prevalent. The influence on Bassi of Spallanzani's views on spontaneous generation has already been implied, and Bassi must have been familiar with the frequent association of fungi with decay and disease. In England an illustrated observation on salmon disease of freshwater fish had been given as early as 1748, and in 1832 the zoologist, Richard Owen, when dissecting a flamingo which had died at the London Zoo, found the lungs lined with a vegetable mould and concluded that there were Entophyta as well as Entozoa. The trail became even warmer when, as cited by Bassi, Profs. Configliachi and Brugnatelli, of Pavia, suggested that the muscardine disease had a mycotic origin because of the fungus smell associated with silkworms killed by this disease; but to Bassi must go the credit of being more perceptive and persevering than his contemporaries. Bassi's work was in its turn the stimulus that led Schoenlein to discover the mycotic nature of favus in man and it certainly influenced both Gruby and Berkeley; the latter including in his paper on potato blight the first illustration of *Beauveria bassiana* to be published in Britain.

Bassi, if given to verbosity, was a modest and at times almost diffident writer. He was generous to others but he appears not to have suffered fools gladly, for in the preface to "Del Mal del Segno", while appealing to savants and breeders for their observations, he warns them that "to save time and trouble I shall reply only to those which seem to me sufficiently founded in fact to be able to further in some way the progress of science and art". Bassi lived up to his motto: "Quando il Fatto parla Ragion tace, perchè la Ragione è figlia del Fatto, non il Fatto figlio della Ragione" ("When Fact speaks Reason is silent, because Reason is the child of Fact, not Fact the child of Reason").

I am much indebted to Prof. R. Ciferri, of the University of Pavia, for a microfilm of Bassi's monograph, for a portrait of Bassi, and for taking me on a pilgrimage to Lodi, and to Mr. P. J. Yarrow, of the University of Exeter, for translations from the Italian.

[1] Berkeley, M. J., *J. Hort. Soc.*, **1**, 9 (1846). (Reprinted in "Phytopathological Classics", No. 12, 1948).
[2] Zakon, S. J., and Benedek, T., *Bull. Hist. Med.*, **16**, 165 (1944), give English translations of Gruby's papers.
[3] Tortonese, E., *Endeavour*, **7**, 92 (1948).
[4] "Opere di Agostino Bassi" (Pavia, 1925).
[5] Major, R. H., *Bull. Hist. Med.*, **16**, 97 (1944).

OBITUARIES

Dr. Arthur Felix, F.R.S.

THE sudden death of Dr. Arthur Felix on January 14 at the age of sixty-eight removes from the bacteriological world one who had made his home in Britain for nearly thirty years and who had come to occupy, in the niche he carved out for himself, a position of considerable authority. The work he had done, much of it as a young man, had earned for him an international reputation, and it was a source of great joy to himself and his friends when the value of his contributions was recognized in 1943 by his election to the Fellowship of the Royal Society. He was an excellent example of the group of investigators who, trained in the field of chemistry and physics, have turned their attention to bacteriology and added so much to our knowledge of medical science.

Dr. Felix was born of Orthodox Jewish parents on April 3, 1887, in Silesia—now part of Poland—not far from Tarnow. He was educated at a German *Gymnasium*, and then went to Vienna, where he studied chemistry and took his doctorate. After a period of two years or so learning mycology under Lafar, he was called up on the outbreak of war in 1914, and attached to a laboratory in a field ambulance posted near Cracow. There he met Weil, associate professor of bacteriology at Prague, under whom his bacteriological training was begun. The two formed an admirable pair. Between them they observed a peculiar phenomenon that they rapidly adapted to the diagnosis of typhus fever, which was then prevalent on the Eastern front. The Weil–Felix reaction, as it was called, proved of immense value in the differential diagnosis of typhus from typhoid and other fevers of unknown origin, and stimulated a great deal of research to explain why it was possible to obtain a specific agglutination reaction with an organism playing apparently no part in the causation of the disease. Intimately bound up with this reaction was a curious variation observed by Weil and Felix in the behaviour of one of the strains—*Proteus X* 1—which was under some conditions motile and under others non-motile. The association of this change with the serological behaviour of the organism was quickly appreciated, and a distinction established between the loose floccular agglutination dependent on the flagella of the motile form and the compact granular agglutination dependent on the body or

somatic substance present in both motile and non-motile forms. These observations on *Proteus* were later found to fit in admirably with similar observations made several years previously by Smith and Reagh in the United States on a member of the *Salmonella* group, and provided the basis of a wide generalization on the antigenic structure of bacteria.

At the end of the First World War, Felix worked for a time at Prague and, after taking a three-months course in tropical medicine at Hamburg, moved in 1920 to Palestine, where he served as a hospital bacteriologist for some years. In spite of his attachment to Zionism, he was forced to the conclusion that Palestine could not offer him the opportunities for research that he wanted, and he gladly accepted an offer in 1927 by Prof. J. C. G. Ledingham to join the Lister Institute in London. There he settled down among congenial colleagues and added to his reputation by discovering the *Vi* antigen of the typhoid bacillus. In 1939 he was appointed to a post in the Emergency Public Health Laboratory Service, in which he built up what was later to become the Central Enteric Reference Laboratory and Bureau. His development of the *Vi*-phage typing method for 'finger-printing' typhoid bacilli, which had been introduced by Craigie and Yen in 1938, attracted world-wide interest, and in 1947 Felix's laboratory at Colindale was designated the international reference laboratory for the phage-typing of these organisms. Felix retired from the Public Health Laboratory Service in 1954, and returned to the Lister Institute where, with a research grant, he was able to tidy up some of his unfinished work.

Dr. Felix married in 1923 Leah Gluckman, of Tel-Aviv, who survives him. G. S. Wilson

Prof. James Small

Prof. James Small died on November 28 at the age of sixty-six. Born at Brechin, Forfarshire, he was educated at Brechin High School, the Pharmaceutical Society's School, and Birkbeck College (University of London). After graduation he lectured for a brief period at Armstrong (now King's) College, University of Durham, and then at the outbreak of the First World War joined the Black Watch Regiment. He was wounded and invalided out of the Army in 1916, and returned after a period of convalescence to his appointment at Armstrong College. In 1916 he became lecturer in botany at Bedford College, University of London, and in the following year was appointed also lecturer at the Pharmaceutical Society. He left London in 1920 to take the chair of botany in The Queen's University, Belfast, succeeding Prof. R. H. Yapp. He was elected to the membership of the Royal Irish Academy in 1922, and to the fellowship of the Royal Society of Edinburgh in 1926. He held the chair at Belfast until his retirement in 1954, when the Senate of the University bestowed the title of emeritus professor upon him.

Small's first major research was on the Compositae. His work on this family was published as a *New Phytologist* monograph in 1919 under the title "The Origin and Development of the Compositae", and for this research he received the degree of D.Sc. of the University of London. In 1922, Small contributed a chapter to J. C. Willis's book, "Age and Area", on the evolution of the Compositae, and this initiated a series of papers in which he joined Willis in rejecting natural selection as an explanation of the course of evolution, advocating instead the idea of a sudden origin of species. He drew evidence for this from several groups, plant and animal, but particularly from the diatoms and Foraminifera, which have fossil records suitable for quantitative analysis. Recondite in style, these studies on "quantitative evolution" have seemed to some almost perversely out of step with current evolutionary thought; yet by his intensive analysis, Small brought to light quite remarkable regularities in the evolutionary history of the groups that came under his attention, regularities which remain to be explained by any evolutionary theory claiming to have general validity.

His other main line of research concerned *p*H phenomena in plants. He devised a colorimetrical method for the determination of *p*H in plant tissues in the early nineteen-twenties, and the results of numerous observations were brought together in the *Protoplasma* monograph "Hydrogen-ion Concentration in Plant Cells and Tissues" in 1929. His book, "*p*H and Plants", was published in 1947, and another of a more general nature, entitled "Modern Aspects of *p*H", in 1953. In this year also he wrote a contribution on "The *p*H of Plant Cells" to the current series of *Protoplasmatologia* monographs, and during his final illness he completed the correction of the proofs of a contribution on the estimation of *p*H values in living tissues and saps to Paech and Tracey's "Modern Methods of Plant Analysis".

His work on *p*H led Small to an interest in stomatal mechanisms, on which he published several papers. He was also actively concerned with the problems of protoplasmic movement, and devised a technique for its study in living stems. His important observation of very high rates of cyclosis in living sieve-tube elements of marrow is often overlooked, despite its high significance in relation to solute translocation.

Small's many-sided work on evolution and plant physiology was recognized in 1951 by the award of the Makdougall–Brisbane Prize of the Royal Society of Edinburgh, for distinguished research published in the journals of the Society.

His early interest in pharmacognosy was responsible largely for the writing of Small's "Textbook of Botany" (first edition, 1921; fourth edition, 1937), which was intended principally for the use of medical and pharmaceutical students, and which in its encyclopædic nature reflected its author's own vast acquaintance with morphological botany.

For practically a quarter of a century Small was a member of the committee of the British Pharmacopœia, and he served on the council of the Pharmaceutical Society of Northern Ireland from its inception. He wrote innumerable papers on the botanical characteristics of officinal plants, and contributed a long series of beautifully illustrated articles to the journal *Food* on the structure, properties and uses of drugs and spices.

From 1920, when winning a vest-pocket camera in a newspaper competition provided an introduction, Small had an enthusiastic interest in photography, both technical and artistic. He became keenly aware of the potentialities of photography for recording the structures of botanical objects in the magnification range × 1–20, and his superb pictures taken with the Small–Watson camera have been widely published and exhibited. This activity gained him election to the fellowship of the Royal Photographic

Society in 1938—an honour which he treasured as highly as any that came to him in the more academic sphere.

A great lover of argument, Small never failed to stimulate through his perennial heterodoxy, coupled with his impressive width of botanical knowledge. To those who knew him well he was the most kindly and generous of men, full of a humour which was wont to find its expression at times in the gentle teasing of authority, more particularly authority which was itself humourless.

He is survived by his wife, two sons and daughter.

J. Heslop Harrison

Prof. D. R. Boyd

David Runciman Boyd, who died on December 28, gave forty-one years service to university education in Southampton, and was one of the ablest of a very small and steadfast band whose work has made the University of Southampton possible. Born on February 26, 1872, he was the son of the minister of the parish of Mains, near Dundee. His father died when he was only one year old, leaving a widow and three young children in straitened circumstances. The family moved to Edinburgh, and young David attended the then rather spartan John Watson Institution during 1880–86. After a short period on the classical side of George Watson's College, he moved to Glasgow and in 1888 entered the University of Glasgow. He had a distinguished undergraduate career, gaining prizes in chemistry, natural philosophy and mathematics, and in 1892 was awarded the B.Sc. degree with honours in chemistry. With the Robert Donaldson scholarship he studied in Victor Meyer's laboratory at Heidelberg, acting as Jacobson's assistant for a year, and gained the Ph.D. degree. After about two years as demonstrator in chemistry, under Frankland, at the Mason College, Birmingham, he was one of five lecturers appointed in 1896 to the Hartley Institution, Southampton, with the object of bringing the teaching up to university standard. This was so far successful that the Institution became the Hartley University College, with a small and precarious Treasury grant, in 1902. It was largely due to Boyd and his colleague, John Eustice, head of the Engineering Department during 1892–1931, that the College survived the frequent crises of the first decade of this century.

Up to 1919, Boyd never had more than one academic assistant, and the major part of a heavy teaching programme fell on him. He was an exceptionally clear and inspiring teacher: Prof. C. K. Ingold, a student at the College during 1911–13, writes: "he treated us to a most exciting exposition of the whole of Chemistry as a living, growing subject, rich in opportunity for the questing spirit. Werner's resolution of cobaltammines, and Knorr's and Kurt Meyer's work on ethyl acetoacetate came hot from the Annalen or Berichte, yet without sacrifice to the pattern of the lecture course as a whole. Everything was critically (and remarkably soundly) assessed, and some much publicized but unsound work dealt with severely". After 1920, with a somewhat larger staff, though still small by university standards, the teaching was maintained throughout at a very high level until his retirement in 1937.

Until about 1930, Boyd kept research going actively, despite very meagre resources. His name appears on some twenty papers, and another ten by his pupils are on lines initiated by him. He studied various aspects of the chemistry of aromatic compounds, and a series of papers on organic compounds of phosphorus is of particular interest. Two papers on the kinetics of reaction between sodium derivatives of phenols and ethylene oxides are still frequently quoted. He encouraged several other successful lines of research, in different branches of chemistry, in his department. He was awarded the D.Sc. degree of the University of Glasgow in 1902, and frequently examined for that University.

Boyd was invaluable in the administration of the College, in which he took a large part. He was chairman, later dean, of the Faculty of Science for many years, and vice-principal after the retirement of Prof. Eustice in 1931. He was tall, gentle and dignified, with courtly manners; he spoke and wrote clearly and persuasively, and spoke so little of himself that many of his colleagues were unaware that, over several years while holding the chair, he read for the Bar and qualified as a barrister of the Inner Temple. His unvarying maintenance of high academic standards, unselfishness and outstanding integrity earned the confidence of his colleagues; and he was much loved and respected in his own department. He married in 1909, and had two sons; but his later years were saddened by the death of both his sons in 1944 on war service, and his wife died last August. What the University of Southampton owes to him cannot be over-estimated; and he rendered notable services to chemistry both through his own researches and by the inspiration and sound training he gave to many generations of pupils, whose collective contributions to research and to teaching are an imposing monument to their teacher.

N. K. Adam

Prof. P. N. Chirvinsky

Petr Nikolaevich Chirvinsky was born on February 7, 1880, in Moscow in a family of a scientific worker. In 1902 he graduated from the University of Kiev. In 1909 he was appointed professor of applied geology in the Don Polytechnical Institute at Novocherkassk and finally in 1943 he became professor of petrology in the University of Molotov (formerly Perm). He died on June 21, 1955.

A petrologist and mineralogist by profession, Chirvinsky took all allied sciences as his province. In his fifty-three years of academic life, it is estimated that he published 380 papers and books comprising 6,760 printed pages, and covering such varied subjects as petrology, mineralogy, crystallography, meteoritics, geology, hydrogeology, astronomy, physics, chemistry and geochemistry. Of these the first four were his main preoccupation, and he has to his credit many published descriptions of igneous, metamorphic and sedimentary rocks, minerals and meteorites. He was particularly interested in the mineral composition of granites and other igneous rocks, and in this connexion he elaborated a method of "geometrical–chemical" analysis (1937) and published a book on the average composition of rock-forming minerals (1953). Another interest was the chemical composition and genesis of minerals, and one of his papers on a uranium mineral was published in English (*Miner. Mag.*, 20, 287; 1925). More than eighty papers and notes were devoted to meteorites. He was also very much alive to the wider problems of cosmology and geochemistry. He was a modest and friendly man, and an excellent and inspiring teacher.

S. I. Tomkeieff

NEWS and VIEWS

The Department of Scientific and Industrial Research : Sir Ben Lockspeiser, K.C.B., F.R.S.

In March of this year Sir Ben Lockspeiser ceases to be secretary to the Committee of the Privy Council for Scientific and Industrial Research. He was appointed in 1949, and has, therefore, had the responsibility of guiding the largest of the Government's Research Councils through a most important phase of its development. When he took over, D.S.I.R.'s recurrent expenditure was little more than £3 million, and its capital grant about £100,000. To-day the first runs at £6·5 million, while the second stands at £1·3 million. In parallel, D.S.I.R.'s scientific staff has increased from 1,700 to 2,400. Sir Ben was ideally suited to bring about this expansion. He brought to his task considerable administrative capacity and experience, and a life-long knowledge of Government scientific establishments. From 1920 until 1939, when he became assistant director of scientific research at the Air Ministry, he was a member of the Royal Aircraft Establishment, Farnborough, and before moving to D.S.I.R., he was successively director-general of scientific research, Ministry of Aircraft Production, and chief scientist to the Ministry of Supply. During the period of his forceful reign, Sir Ben has constantly kept to the fore the conception of D.S.I.R. as an agency which is concerned not only in the cultivation of new scientific knowledge, but also in seeing that this knowledge finds its fruitful application. Under his influence the research associations have prospered, and at the same time D.S.I.R. has strengthened its connexions with industry by establishing a central Intelligence Division.

Sir Ben's influence has also been both valuable and extensive outside the domestic affairs of D.S.I.R. As an official member of the Defence Research Policy Committee (see p. 251 of this issue) he has shared the responsibility of defining the general scientific needs of the Armed Services, and, where necessary and possible, has seen that the facilities of D.S.I.R. have been available for work in this field. He has also been an official member of the Advisory Council on Scientific Policy, through which he has been directly concerned with a wide variety of topics that fall within the field of civilian science, and most particularly with the problem of scientific man-power. Since 1953 Sir Ben has, in addition, been president of the European Organization for Nuclear Research. Sir Ben's voice will be much missed in the Council rooms to whose work he has always contributed with wisdom, and with force tempered by good humour. Although he has now come to the end of his official term of service at D.S.I.R., it is to be hoped that the country will still be able to learn his opinions about the broader affairs of science, and that he will find the opportunity to make his views on science and industry, as well as on scientific education, known to increasingly wider audiences.

Prof. H. W. Melville, F.R.S.

Prof. H. W. Melville, Mason professor of chemistry in the University of Birmingham since 1948, succeeds Sir Ben Lockspeiser as secretary of D.S.I.R. Prof. Melville was educated at George Heriot's School, Edinburgh, and at the Universities of Edinburgh and Cambridge. During 1933–42 he was a Fellow of Trinity College, Cambridge, and between 1940 and 1948, before taking up his appointment in Birmingham, professor of chemistry in the University of Aberdeen. He was elected to the fellowship of the Royal Society in 1941, and was awarded the Davy Medal last year for his distinguished contributions to the chemistry of macro-molecular substances. His researches before 1939 were concerned with the mechanism of gas-phase reactions, especially in slow and explosive combustions, and with the photochemistry of polyatomic molecules and photosensitized reactions. Inquiries into gas-phase polymerization reactions, which Prof. Melville took up during this period, laid the foundation for much of his post-war researches. These were mainly directed to the study of liquid phase polymerization ; and the development and combination of a series of completely new physical methods, including highly sensitive methods of following liquid phase reactions, led to the complete elucidation of the kinetics and chemistry of this process. Considerable advances were also made in the study of the breakdown of large molecules, while the use of radioactive tracers allowed Prof. Melville to extend his investigations on the chemical side. All these developments have shown how to synthesize completely new types of macro-molecules. Much of this will no doubt be reviewed by Prof. Melville in the Bakerian Lecture of the Royal Society which he is due to deliver in the near future.

Prof. Melville brings to his new responsibilities not only great achievements as an investigator, but also considerable experience of advisory work on behalf of the Government. He was a member of the Advisory Council of D.S.I.R. between 1946 and 1951, and has also served on the Advisory Council of the Ministry of Supply ; on the Research Council of the British Electricity Authority ; on the Fuel Research Board ; and on the Advisory Council of the Ministry of Fuel and Power. He was also a member of the Royal Commission on University Education in Dundee. Many new responsibilities will now fall to his lot, including not only the direction of D.S.I.R. but also the representation of its interests on the Advisory Council on Scientific Policy and on the Defence Research Policy Committee. Prof. Melville's great record of achievement and service provides every confidence that the further development of D.S.I.R. has been entrusted to a man who has all the imagination and drive necessary to fulfil his task.

Directorship of the National Physical Laboratory : Prof. G. B. B. M. Sutherland, F.R.S.

Prof. G. B. B. M. Sutherland, professor of physics and director of the Biophysics Research Centre in the University of Michigan, has been appointed director of the National Physical Laboratory. It is expected that Prof. Sutherland will take up the appointment in September next ; Dr. R. L. Smith-Rose will continue as acting director until Prof. Sutherland takes up duty. Prof. Sutherland is a leading authority on infra-red spectrum analysis but of recent years has developed especial interests in the field of biophysics. He was educated at the Morgan Academy, Dundee, and the University of St. Andrews. From 1935 until 1949 he was a fellow of Pembroke College, Cambridge. During the early part of the Second World War, Prof. Sutherland was assistant to the Director of Scientific Research at the Ministry of Supply. In 1941 he was made head of a group carrying out research in Cambridge for that Ministry, the Ministry of Aircraft Production

and the Admiralty on the structure of hydrocarbons. This work led to significant improvements in aviation fuels. In 1947 he became reader in spectroscopy at Cambridge and in 1949 was appointed to his present post in the University of Michigan. He was elected a Fellow of the Royal Society in 1949.

Zoology in University College, Swansea: Prof. E. W. Knight Jones

DR. E. W. KNIGHT JONES, deputy director of the Marine Biology Station at the University College of North Wales, Bangor, has been appointed to be the first occupant of the chair of zoology in the University College of Swansea. Educated at Epsom College and at the University College of North Wales, Dr. Knight Jones graduated with first-class honours in zoology in 1938 and started research on the nervous system of *Saccoglossus*, one of the Enteropneusta. He was awarded a Meyricke Scholarship of Jesus College, Oxford, in 1939 and continued his research under Dr. (now Prof.) J. Z. Young. At the outbreak of war he joined the Army, being commissioned in the Royal Artillery. He was promoted captain, mentioned in dispatches and wounded during the crossing of the Rhine in 1945. On demobilization he returned to Oxford to complete his studies on the enteropneustan nervous system, for which he was awarded the degree of D.Phil. From 1946 he was engaged on shellfish research under Dr. H. A. Cole in the Ministry of Agriculture and Fisheries, being naturalist-in-charge at the then newly formed Burnham-on-Crouch station, until he returned to Bangor in 1950 on the foundation of the Marine Biology Station. Much of Dr. Knight Jones's work has been concerned with problems of larval settlement, to which he has made contributions of fundamental importance. He has shown the importance of gregariousness during spat-fall and has directed attention to the constancy of direction of metachronal waves and its relation to the direction of beat in the ciliary tracts of both larvæ and adults. Recently he has shown that many planktonic animals are sensitive even to small changes of hydrostatic pressure, a finding that is likely to prove of great significance in relation to vertical movements.

Institution of Electrical Engineers: Awards

SIR STANLEY ANGWIN has been elected to honorary membership of the Institution of Electrical Engineers in recognition of his outstanding life's work in the field of telecommunication, both national and international, and of his distinguished services to the Institution. Sir Stanley, who was engineer-in-chief of the Post Office during 1939–46, is a past president of the Institution and was awarded the Faraday Medal of the Institution in 1953 (see *Nature*, 171, 287; 1953).

Prof. G. W. O. Howe

THE thirty-fourth award of the Faraday Medal of the Institution has been made to Prof. George William O. Howe for his pioneering work in the study and analysis of high-frequency oscillations and on the theory of radio propagation, and for his outstanding contributions to engineering education. After graduating from Armstrong College (now King's College), University of Durham, Prof. Howe gained industrial experience in electrical engineering, and then in 1905 went to the Imperial College of Science and Technology, London, as a lecturer, being appointed assistant professor of electrical engineering in 1909. For a brief spell in 1920 he was head of the Department of Electrical Standards and Measurements of the National Physical Laboratory, and in the following year he was appointed James Watt professor of electrical engineering in the University of Glasgow, a position he held until his retirement in 1946. During 1920–22 he was editor of the *Radio Review*, and in 1926 became editor of the *Wireless Engineer*, an office he still holds. Prof. Howe's association with the Institution of Electrical Engineers began in 1905 when he was elected an associate member. He took a prominent part in the formation of the Wireless (now Radio and Telecommunication) Section of the Institution in 1919, and in 1924 he gave the first of the Institution's Faraday Lectures, his subject being "World-Wide Radio Telegraphy".

New York Academy of Medicine: Awards

THE Medal of the New York Academy of Medicine has been awarded to Dr. Eugene Floyd DuBois for his fundamental contributions to the science of metabolism and the understanding of disease, for his work in the development of clinical science and medical education and for his services to the United States during two World Wars in the solution of physiological problems in aviation medicine and submarine warfare. The Medal was founded twenty-seven years ago and is awarded from time to time for distinguished service in medicine, the present award being the tenth to be made. Dr. DuBois, who was formerly professor of physiology and biophysics in Cornell University Medical College, New York, is probably best known for his studies of the physical mechanism of fever, particularly his calorimetric work in skin temperature and heat radiation. The Academy has also presented a plaque to Dr. Malcolm Goodridge for his outstanding services to the Academy, particularly as president during the early years of the Second World War.

Imperial College of Science and Technology

QUESTIONS were raised in the House of Lords on January 25 regarding the expansion of the Imperial College of Science and Technology. The Secretary of State for Commonwealth Relations, replying for the Lord President of the Council, said that, in view of the urgent need to increase the output of scientists and technologists in Britain, the Government has decided to adhere to the scale of development for the Imperial College originally announced. To enable this decision to be given effect, new premises for the Imperial Institute will be provided elsewhere. He said that he does not think there is now anything to hold up the original building plan of the Imperial College; the Government is fully aware of the urgency of the problem of expanding technological education.

Manchester College of Science and Technology

SPEAKING at the associateship ceremony of the Manchester College of Technology on November 26, the principal, Dr. B. V. Bowden, referred to the conferment of a Royal Charter on the College, with the title of the Manchester College of Science and Technology, and paid tribute to the efforts of the past: beginning in 1824 with the building of a Mechanics Institute, which was opened in May 1827, successive developments led to a much larger Institute in 1857, to a Technical School in 1883 and then to what Mr. A. J. Balfour described, in opening it in October 1902, as "the greatest fruit of this kind of

municipal enterprise in the country". Three years later, the relation with the University of Manchester was established, under which the University's Faculty of Technology has ever since been in the College of Technology and the professorial staff of the College have been members of the University Senate. Even half a century ago the building just then completed was too small to meet the demands being made upon it, and the building expected to be completed shortly is a little bigger than the one for which plans were first approved in 1914. Two years before the latter date, however, the principal, Dr. Maxwell Garnett, had pleaded for more advanced education for engineers, claiming that while the practical man was as necessary as ever, the practical man of the day was the man who could readily apply theory to practice, when practice was governed by something better than rule of thumb. At that time, the position of Britain in the vanguard of progress was already threatened by developments attributable to the growth of the technical institutions in Germany, the Netherlands and Switzerland, where by 1910 there were twelve such institutions of university rank as against two in Britain. Dr. Bowden said that nowadays the survival of Britain as a great nation depends on the production of many more scientists and technologists than are at present being trained; after referring to the value of the part-time training given by the College, he added that it is hoped to develop an institution which would derive its strength from the traditions of the past hundred and thirty years, but which would be specially adapted to meet the changing needs of to-day, contributing both the ideas and the men which industry needs.

School for Advanced Study at the Massachusetts Institute of Technology

A School for Advanced Study has been established at the Massachusetts Institute of Technology, with Dr. Martin J. Buerger, professor of mineralogy and crystallography, as director. The School will be similar in its objectives to the Institute for Advanced Studies at Princeton, but will differ in that it will be an integral part of the Institute and serve as an extension of the level pursued at the existing Undergraduate and Graduate Schools. These three Schools will thus constitute the three 'horizontal' levels of the Institute, and the staff will continue as members of the five 'vertical' organizations, namely, the Faculties of Science, Engineering, Architecture and Planning, Industrial Management, and Humanities and Social Studies. For the moment, the staff of the School for Advanced Study consists solely of the director and a secretary. Scholars will be invited by the Institute to pursue advanced study and will have the status of Fellows in the School. Up to now there have been approximately a hundred such people a year, from fifteen countries, studying at the Institute, and they have been registered as 'guests' or 'visiting Fellows'. It is hoped that ultimately the new School will provide a centre and adequate housing for Fellows and guests and, by means of special programmes and other schemes, arrange for them to meet in informal conferences among themselves and with the permanent staff of the various Faculties of the Institute. Dr. Buerger, who will assume the office of director on July 1, was a student at the Institute in 1920 and has been on the staff since 1925, becoming a full professor in the Department of Geology in 1944. A former president of the Mineralogical Society of America, he is widely known for his studies in theoretical mineralogy and for the development of new theories of crystal structure analysis.

Nuclear Weapons and Civil Defence

The first of a series of pamphlets in Vol. 1 of the "Manual of Civil Defence", prepared by the Home Office and Scottish Home Department, is one on "Nuclear Weapons" (pp. 55. London: H.M.S.O., 1956; 2*s*. 6*d*. net), and replaces "Atomic Warfare" ("Basic Training", Vol. 2, Pamphlet No. 6). Freely illustrated with photographs, diagrams and maps, and lucidly written so that the intelligent layman should have no difficulty in understanding the exact nature of the hazards of nuclear explosions and what can be done to mitigate them, it is nevertheless not a popular exposition for the general public, and something much simpler and more concise would better serve to bring home to the ordinary citizen the value of those few simple precautions which they could themselves take to reduce casualties outside the immediate area of an explosion. The major part of the pamphlet is concerned with the hazards from nuclear radiation, including the immediate and delayed dangers and protection from fall-out as well as the control of exposure to radiation in contaminated areas, but there are chapters on the fire risk and on blast. It is, in fact, in these chapters that the pamphlet best indicates the contribution which common-sense and such simple measures as white-washing windows and remaining under cover can offer against thermal radiation and blast, respectively, and the pamphlet could assist in providing the basic information and stimulating simple practical measures needed. That such measures are severely limited in scope, and that the tactical and administrative measures which are not considered in the pamphlet are of the utmost importance, will not be gainsaid. Nevertheless, a campaign of public education is of the utmost urgency to enable ordinary people to take whatever precautions are in their power, some of which, such as the construction of trenches or shelters and the choice of one type of house as against another, demand a certain amount of foresight and preparation.

Preservation of the Lake District

The report and newsletter for 1955 of the Friends of the Lake District (pp. 25. Ulverston: Friends of the Lake District, 1955) comments on the growing support for the idea that national parks should be financed nationally, and the proposal that some part of the annual interest on the National Land Fund should be used for this purpose has been widely canvassed. A detailed resolution has been submitted to the Chancellor of the Exchequer by the British Travel and Holiday Association, and the Financial Secretary to the Treasury has received a deputation of members of Parliament on the matter and has agreed to raise with the Chancellor the possibility of including some suitable provision in the Finance Act accompanying the next Budget. Moreover, the Minister of Housing and Local Government, at a recent conference of park planning authorities, in suggesting that the time had come to review the working of the Act, emphasized his full support for any efforts to resist undesirable encroachment or disfigurement in the national parks. The newsletter recapitulates in some detail the events which led, in June 1955, to the decision of the North-Western Electricity Board to lay underground the whole of the much-debated

line up Borrowdale, between Keswick and Resthwaite, including a loop-line along the far side of Derwentwater, without extra charge to individual consumers in the valley. This result is attributed to the intervention of the Minister of Fuel and Power, following the representations made by the National Parks Commission to that Minister and to the Minister of Housing and Local Government. Negotiations in regard to Langdale and in regard to Patterdale continue. The society, with the Council for the Preservation of Rural England, has also reached a satisfactory agreement with the Forestry Commission in regard to any land within the 300 square miles of the central Lake District which the Commission might acquire and which was not under woodland in 1936. The National Trust has also agreed in replanting its woodlands at Loweswater and above Buttermere to bring in a firm policy of introducing or carefully re-generating hardwoods wherever the ground is not too wet.

Brazilian Association for the Progress of Science

THIS year's meeting of the Brazilian Association for the Progress of Science will be held at Ouro Preto (Minas Gerais) during July 2–7, and as planned at present there will be eighteen sections, although this number is likely to be reduced later. The main themes for the meeting will include "Problems of the Atomic Age" (Physics Section), "The Problem of Petroleum in Brazil" (Geology Section) and "University Teaching of Science" (Education Section). Other topics of special interest are "The Use of Isotopes in Technology", "Ionospheric Exploration", "Metallurgy of Radio-active Metals", "Animal Movement" and, possibly, "*Rauwolfia serpentina*". The great natural resources of Minas Gerais State and the existence of a mining school in Ouro Preto give a specially geological regional interest to the meeting, which will be brought out in various papers to be read on mining for iron and gold, on petroleum and on mineralogy and geology generally. Among the British contributions to the meeting will be a showing arranged by the British Council of a number of recent scientific films, and an address on "The Teaching of Science and Technology in British Universities" by Mr. F. M. Beatty, the British Council's science officer in Brazil.

Oil and Colour Chemists' Association: Eighth Technical Exhibition

THE eighth technical exhibition of the Oil and Colour Chemists' Association, organized by the London Section of the Association, will be held during March 20–22 in the Royal Horticultural Society's New Hall, Grey Coat and Elverton Streets, London, S.W.1, at the following times: March 20, 3 p.m.–8.30 p.m.; and March 21 and 22, 11 a.m.–7.30 p.m. As before, the theme of the exhibition will be the presentation of technical advances in those industries supplying the paint, varnish, printing ink, linoleum and other allied industries. The area covered by the exhibition and the total number of companies and research associations exhibiting (eighty-two in all) are the largest yet reached. A ninety-two page catalogue of the exhibition has been prepared and is available. Admission to the exhibition is free. Further information can be obtained from the general secretary, R. H. Hamblin, Oil and Colour Chemists' Association, Memorial Hall, Farringdon Street, London, E.C.4.

Optics Meetings in the United States

THE International Commission for Optics will meet this year in the Massachusetts Institute of Technology, Cambridge, Mass., during March 28–April 3, and will devote four days to a symposium on "Frontiers in Physical Optics", which will be open to all interested. At the symposium the following topics will be discussed: new phase-contrast and interference microscopic and measuring devices; thin films and filters; meteorological optics; and nuclear optics. The main papers for these sessions have already been invited and prepared, but time will be reserved for free discussion. In addition to these events, the regular spring meeting of the Optical Society of America will be held during April 5–7 in Philadelphia, Pennsylvania, and this also will be open to all interested. Further information about the meetings can be obtained from Dr. S. S. Ballard, Visibility Laboratory, Scripps Institution of Oceanography, University of California, San Diego 52, Calif.

Announcements

RAYMUND L. ZWEMER, formerly chief of the Science Division of the Library of Congress, has been appointed head of the Division of International Co-operation for Scientific Research in the Natural Science Department of the United Nations Educational, Scientific and Cultural Organization. He will be responsible for Unesco's relations with international scientific unions and other organizations concerned with scientific research on an international scale.

SIR ERIC RIDEAL is to deliver a course of three lectures on "Colloids and their Behaviour" at the Royal Institution on February 28, March 6 and 13 at 6 p.m. This is a refresher course intended primarily for school teachers. Members of the London Branches of the Science Masters' Association and the Association of Women Science Teachers will be notified by their Associations about applications for tickets; non-members should apply to a local branch secretary of one of the Associations.

THE Institution of Naval Architects is offering two scholarships in naval architecture—the I.N.A.–Elgar–Martell of £275 a year, and the Vickers-Armstrongs of £220 a year—both of which are tenable for three or four years at a university institution. They are open to British subjects, less than twenty-three years old, who have been employed in shipbuilding. Applications should be made by May 31 to the Secretary of the Institution at 10 Upper Belgrave Street, London, S.W.1.

THE Council of Europe and the High Authority of the European Coal and Steel Community will award jointly a number of fellowships this year for research into problems of European interest. The fellowships will be worth 300,000 francs each (about £300). The fields of work applicable are as follows: efforts to achieve European integration by co-ordination in the political, social, economic, scientific or educational fields; European civilization in relation to contemporary problems (philosophy, history, literature or the arts); economic, legal or social problems relating to the European Coal and Steel Community and its institutions. Candidates from Great Britain should obtain their application forms from the Education Division, British Council, 65 Davies Street, London, W.1, and return them before March 15.

THE NATURE CONSERVANCY

ANNUAL REPORT

THE Nature Conservancy has virtually completed the building up of its organization and the initial surveys of areas of scientific interest, and in the year ended September 30, 1955, covered by its sixth annual report*, it has been concerned mainly to secure the most effective use of the resources now at its disposal. During the year, the Conservancy declared sixteen new nature reserves in Britain and added to four previously declared, bringing the total acreage to 79,035 acres in thirty-five reserves. The whole programme for national nature reserves was reviewed during the year and, except for a handful of sites presenting special difficulties, it is hoped to complete the programme of declarations within the next four years. Unfortunately, some of the areas of special scientific interest which cannot be included in this programme are suffering considerable damage and losses, and the Conservancy hopes that more local authorities will use their powers to create local nature reserves under the National Parks and Access to the Countryside Act, and also that more voluntary action will be taken by both national and county trusts and societies. Of the three such local reserves noted in this report, that at Ravenglass had another successful season, at Aberlady Bay the legal validity of by-laws applicable to the foreshore made by the Nature Conservancy and appropriate local authorities was established, and by-laws for the protection of the scientific interest in the Castle Eden Denes Local Nature Reserve have been submitted to the Secretary of State for approval.

Financial stringency, as anticipated, greatly embarrassed the Conservancy, compelling postponement of fencing of reserves and long overdue woodland operations. The grant-in-aid received during the year for the general expenses account was £154,500, and expenditure was £157,992, while the grant-in-aid on capital expenditure account was £47,500, including £30,000 for purchase and equipment of the new London headquarters at Belgrave Square, and expenditure was £47,256. Fourteen new research grants, totalling £10,934, were awarded, and twenty-seven grants were continued or renewed; but the funds available for this purpose and the programme of scientific work were quite inadequate. The implications of this financial position and the comments of the Conservancy on co-operation and co-ordination and the like are discussed elsewhere in this issue (p. 245); references to the new nature reserves have already been made in these columns. The following notes are accordingly limited to the scientific work of the Conservancy, whose total staff is now 130, forty-two of whom are scientifically qualified.

The two research stations at Merlewood, Morecambe Bay, and at Furzebrook, Poole Harbour, and the Field Station at Anancaun, Kinlochewe, have now completed two seasons of field-work, and the Moor House Field Station on the Westmorland Pennines three. Much of the summer of 1955 was particularly favourable for field-work. The primary work of survey continued, particularly for existing and projected nature reserves; but the emphasis is shifting to intensive specialist investigations of sites of major importance, particularly in connexion with programmes of research. A more intensive survey of distributions is also being carried out with the assistance of such bodies as the Botanical Society of the British Isles. In this work amateur botanists are providing many of the observations. Other examples are the duck counts and the comprehensive survey of inland waters being undertaken by the Wildfowl Trust. Two tentative forest maps have been prepared for Scotland, the first showing the present distribution of native birch, oak, pine, alder and ash wood, and the second attempting to reconstruct the distribution of Scottish forests in the first four centuries of the Christian era, or as it could have been to-day in the absence of man's activities.

Such surveys can be of great value in decisions on land use, and during the year at the Forestry Commission's Gisburn Forest, hardwoods and coniferous trees have been planted on a series of plots statistically designed to yield precise comparisons of productivity and changes in soil status for the different types of timber, and also for sheep-rearing. By this means it is hoped to secure fundamental data of effects of grazing and tree-growth together with practical data on the economic use of hill lands of a type very common in northern and western Britain. Nature Conservancy scientists have collaborated with the Natural Resources (Technical) Committee in a review of the relative advantages and disadvantages of forestry and agriculture on marginal land. An extensive survey of floods and soil erosion resulting from modern changes in land use was begun in Scotland.

The ecological management programme for the Yarner Wood Nature Reserve on the edge of Dartmoor was initiated, with the principal long-term aim of re-constituting a naturally regenerating wood of the type believed once to have covered much of south-western England, and a favourable start was made in the experiments on reconstitution of high-altitude woodlands at Moor House. Investigations of soil invertebrates at Merlewood Research Station indicate that certain amino-acids essential for the maintenance of animal life are more abundant in the fallen leaves of some plants than of others, and free-living nematode worms are also being investigated with the view of determining what are the nematode faunas of soils and litters beneath natural and planted woodlands of different species of trees. A survey of wood ants showed that *F. rufa* is more abundant in the limestone woodlands near Grange-over-Sands but has declined over the past half-century in the Windermere area, apparently as a result of invasion by bracken. On the Hartland Moor Nature Reserve, the distribution of all ant species has been mapped by transect over 10 hectares, and a more detailed permanent quadrat has been established over about 600 square metres.

Intensive studies of peat nutrients have been started at Merlewood Research Station, and work on moorland animals at Moor House has revealed interesting relationships between the moth *Coleophora caespititiella* and its food plant *Juncus squarrosus*

* Report of the Nature Conservancy for the year ended 30th September, 1955. Pp. iv+56+12 plates. (London: H.M. Stationery Office, 1955.) 4s. net.

(heath rush). With the co-operation of the Ministry of Transport and Civil Aviation radar station at Great Dun Fell (2,780 ft.) of the Meteorological Office, it is hoped to initiate a range of automatic recordings of meteorological data at that point, which will in future be compared with those being taken at Moor House and at Alston. Establishment of the Cairngorms Nature Reserve has made possible a partial filling of a serious gap in the snow survey of Britain, and autographic temperature-recording has now started at Loch Etchachan (3,058 ft.), where weekly readings are taken during April–October.

The present status in Britain of the hare has also been investigated, as well as the population density and feeding habits of the buzzard in sample areas throughout the country. No evidence of an extensive switch of diet by predators in directions harmful to human interests has so far been traced to the disappearance of rabbits. The measurement of long-term changes in the vegetation on grasslands, particularly where rabbit-grazing has been suddenly reduced by myxomatosis, continued, and at Bridgwater Bay measurements were made of the rate of shingle movement along the beach and its relation to the growth of the cord grass, *Spartina townsendii*. At Braunton Burrows the closing of blow-outs by brushwood and hessian fencing, together with the planting of *Ammophila arenaria*, increased the height of the coastal dune ridge by five to six feet, while the untreated central ridge was lowered by a similar amount and the inner ridge encroached landward by about 25 ft. a year. As a result of the Conservancy's continued experiments on spraying of roadside verges and hedgerows, the Ministry of Transport and Civil Aviation issued a circular on the use of selective weedkillers containing substituted phenoxyacetic acids for control of roadside vegetation to all appropriate local authorities. The Nature Conservancy also investigated during April–June 1955 complaints of killing of lambs by golden eagles in Lewis, as a result of which no amendment of the law forbidding the killing of this bird was considered necessary.

A list of scientific publications of the Conservancy is included in the report.

THE NATIONAL PARKS COMMISSION, GREAT BRITAIN

ANNUAL REPORT

WITHIN the limits set by its financial resources and the neglect to implement fully the administrative provisions of the National Parks and Access to the Countryside Act, the sixth annual report of the National Parks Commission, covering the year ended September 30, 1955*, gives a reasonably encouraging record of progress. The education of the public and of government departments, public corporations and local authorities has been patiently, tactfully and persistently pursued. Firm opposition has been maintained, so far as the Commission's powers permit, to proposals which threaten the purposes for which the parks were created, and although there is no immediate prospect of extending the list of areas designated as national parks the Commission is giving increasing attention to the designation of areas of outstanding natural beauty. Administrative arrangements for the Exmoor and Yorkshire Dales National Parks have not yet been settled, nor for the Brecon Beacons Park or the Northumberland National Park designated on September 20, 1955. At the same time, the Border National Forest Park, including Kielder Forest and the adjoining forests of Kershope in Cumberland and Newcastleton and Wauchope in Roxburghshire, was established in a joint notice issued by the Forestry Commission and the National Parks Commission.

Generally, the administration of the parks proceeded smoothly, and the Commission advocates the introduction of a system of retirement by rotation for each park planning authority, so as to secure some flexibility and continuity of membership. The Commission commends particularly the activity of the Peak Park Planning Board in securing public access to the Kinder and Bleaklow plateaux: the seven access agreements already approved by the Minister cover some 9,345 acres. Much positive action has been taken in providing car parks, the improvement of caravan sites and the removal of undesirable advertisements; and the Board's warden service has earned the gratitude of landowners and farmers for their work, especially for their help in freeing sheep during winter snowstorms. The Lake District Planning Board has likewise given much attention to camping and caravan sites, car parks, the planting of trees and removal of offensive advertisements, and its lease of a large house at Hassness, Buttermere, to the Ramblers' Association Services, Ltd., for use as a hotel is characterized as a milestone in the history of national parks in Britain. At the opening ceremony the Commission's chairman, Lord Strang, congratulated the Board also on being the first park planning authority to provide a new public right-of-way, and on opening the first camping and caravanning site to be available under the powers of the Act. The activities of the other park planning authorities have been on similar lines. The Snowdonia Joint Advisory Committee, for example, is giving increasing attention to publicity, and, like the Pembrokeshire National Park Committee, to the clearance of disfiguring structures from sites used during the War by the Services. The Dartmoor National Park Committee has been asked to deal informally with the denial of access, and the Committee has diligently pursued various methods of dealing with the litter problem. The programme of the North York Moors Park Planning Committee includes a scheme for the protection of the wild daffodils in the valley of the proposed Farndale Local Nature Reserve and publication of a guide book to the Reserve.

In referring to the question of a National Park in Cornwall which has recently been examined once more, the Commission expresses some doubt whether the long, narrow and discontinuous coastal stretches of Cornwall are in all respects suitable for designation as a national park, and whether their administration as such would be practicable. It proposes, therefore, to consider designating coastal areas in Cornwall, and also in Devon and Dorset, with as much of their hinterland as merits inclusion, as areas of outstanding beauty. The experience gained in this way should show whether the provisions of the Act in regard to such areas are adequate, or whether some further legislative measure of protection is required. The Commission has in the meantime already made proposals for designating the Gower Peninsula and the

* National Parks and Access to the Countryside Act, 1949. Sixth Report of the National Parks Commission for the year ending 30th September, 1955. Pp. iv+60+8 plates. (London: H.M. Stationery Office, 1955.) 4s. net.

Quantocks as areas of outstanding natural beauty, and is in informal consultation with the county councils about the Surrey hills and the Lleyn. The effect of such designation is chiefly to apply to such areas the powers conferred by the Act for the preservation and enhancement of natural beauty, and projects for these purposes, approved by the Minister, qualify for Exchequer grants of 75 per cent.

The other area considered by the Commission during the year as a possible national park, the Broads, presents problems not encountered elsewhere. The Broads themselves are diminishing in area, and this encroachment of land on water results from a complicated natural process not yet fully understood. Neither the origin of the lagoons nor the causes of their in-filling has yet received more than superficial investigation, and the Commission considers that such a scientific survey is an essential preliminary to any decision as to whether and at what points and at what cost restoration could be undertaken with any hope of success. Arrangements for such a survey are being discussed with the Nature Conservancy and the Ministry of Housing and Local Government, and it is hoped that the task will be undertaken by the Nature Conservancy in the near future.

Disappointment is again expressed at the slow rate of progress with the 'long distance routes', and the Commission's dissatisfaction with the Minister's decision to uphold the Manchester Corporation's contention in regard to the Pennine Way and Crowden Great Brook is recorded. Little progress was made in the establishment of new rights of way for the Cornwall north and south coast sections of the South-West Peninsula coast path; but more encouraging reports are given of the Pembrokeshire coast path, the Flamborough coast route and the South Downs route; a Welsh Highland route is under consideration. The Commission has been able to increase its publicity activities and plans to make more information available about the national parks and the long-distance routes and, as already noted, the ever-present problem of litter receives increasing attention under the publicity campaign with the Country Code.

In regard to development questions, the Commission notes that the Service departments consult the Commission on their proposals for the acquisition of land and erection of buildings and associated works required for the defence programme when these fall within areas in which the planning authorities know the Commission is interested. To ensure that the Commission is made aware of such proposals at the earliest opportunity and to facilitate liaison, the Commission now proposes to supply the Service departments with copies of special maps showing the areas in which it is interested. The Commission's views on the reconciliation of the claims of amenity with the duties of area boards to supply electricity at the lowest possible cost are reiterated; as a result of a general discussion with the Central Electricity Authority in which the Commission stressed the value of early consultation on new projects in areas of special landscape value, it is hoped to build up local liaison and by its means reach acceptable compromises. Meanwhile, the Ministry of Fuel and Power announced on June 27 that the North-Western Electricity Board has agreed to lay underground the whole of the new supply lines as far as Rosthwaite, including the circuit of Derwentwater, but decision on the remaining sections of the Borrowdale line are awaited. The Board has also announced that there will be no additional charge to consumers for the Hartsop scheme or in any other area where the Board is placing lines underground to preserve the beauty of the existing scene. As regards the North Wales hydroelectric power proposals, the Commission, while not offering outright opposition to the Bill embodying the Ffestiniog and Rheidol schemes, has submitted a detailed memorandum directing attention to points requiring special consideration, and it insists that it is essential that its representations should reach the Parliamentary Committee in the form in which they are made. This procedure has now been agreed with the Minister.

In regard to the proposed road racing circuit in the Peak District National Park under discussion by the Derbyshire County Council, the Commission records the opinion that it cannot see how any such proposals could be consistent with the maintenance of the area as a national park. The Conference of Park Planning Authorities held in London on July 26 provided a valuable opportunity for discussion of problems and for the demonstration of community of view.

THE DEVELOPMENT OF THE POLAROGRAPH

THE thirtieth anniversary of the invention of the polarograph was marked by Prof. J. Heyrovský's recent visit to Great Britain at the invitation of the Polarographic Society, when he took the opportunity of delivering his presidential address to the Society, given in London at the Royal Institution on November 16. Prof. Heyrovský began by pointing out that 1925 was to some extent a nominal date for the invention of the polarograph. Like most inventions, it took a year or so to conceive and develop. The original design is still in use, and its performance is, in fact, superior to many of the commercial instruments which have been developed from it.

The exact reproducibility of the current-voltage curves obtained with the dropping-mercury electrode had made it worth-while to construct an automatic device (the polarograph) for the purpose of recording such curves. Therefore, in the original meaning of the word 'polarography' the use of an exactly reproducible electrode was of greater significance than the use of automatic recording. In recent years, however, there has been a tendency to neglect the importance of reproducibility and to apply the term 'polarography' to the automatic recording of current-voltage curves in general. Nevertheless, Prof. Heyrovský considered it desirable to restrict the use of the word to the investigation of all aspects of the dropping- or streaming-mercury electrode. These include a number of phenomena that are studied by current-time or potential-time curves. The current-voltage curves of solid electrodes, which were studied many years before the introduction of the polarograph, were not reproducible and so did not constitute polarography in the strict sense of the word, even though they might be obtained by means of the polarograph. Such considerations govern the inclusion of material in the well-known bibliography which is maintained by the Polarographic Institute of the Czechoslovak Academy of Science.

With regard to the capillary, the mercury flow-rate should not exceed 2 mgm./sec. In concentrated solutions, failure to adhere to this condition leads to

unwanted maxima of the second kind, and Kryukova has attributed these to stirring of the solution in the vicinity of the drop. Kinks in the plastic tube which joins the capillary to the reservoir can be discouraged by a specially bent capillary assembly. The introduction of the horizontal capillary by Smolef is of considerable interest, for the resultant current-voltage curves are smoother than those obtained with the vertical capillary, disturbances are absent and the oscillations due to drop formation are greatly reduced. Current-time curves of single drops show that the horizontal electrode obeys the Ilkovič equation more exactly than the vertical one. The horizontal electrode is conveniently achieved by bending the tip of a vertical capillary, so that the last 2 mm. or so is in the horizontal plane. The control of drop-time by the use of a small electromagnetic hammer is now proving useful, not only for the synchronization of the twin-electrode systems employed in subtractive or derivative polarography, but also for any circumstances in which it is desirable to reduce the drop weight from its natural value. The streaming-mercury electrode, originally introduced for oscillographic experiments, has proved useful in ordinary polarography, and an equation for its diffusion current has been introduced by Ríus, Llopis, Polo and Koryta.

Small fluctuations in the potentials of the two mercury pools as well as in the rate of flow of mercury through the twin capillaries have proved a practical hindrance to the elegant subtractive method. On the other hand, derivative curves are readily obtained by means of two synchronized electrodes immersed in one solution and differing in potential by about 10 mV. throughout the polarogram. Vogel and Říha have obtained derivative curves from a single capillary by means of a condenser-resistance circuit (their publication appeared about a year before that of Lévêque and Roth), and in this case it is necessary for the applied voltage to vary linearly with time. In yet a third method, a single capillary can be made to yield derivative curves by the use of a mirror galvanometer having a special 'two-coil' suspension. Here, the passage of electrolytic current through the first coil induces its time-derivative in the second one. The general advantage of the derivative curve is that its maximum gives information both on the half-wave potential (the quality) and on di/dE (the quantity) of the electroactive substance. On the other hand, the sensitivity is only about 5 per cent of that obtainable from the normal polarogram. Furthermore, apart from the method, which employs twin capillaries, the half-wave potential depends on both the rate and direction of the applied voltage. Any discussion of derivative polarography would be incomplete without reference to the square-wave polarograph developed at Harwell by Barker and Jenkins; in its sensitivity, this instrument greatly exceeds any polarograph which has so far been developed.

Attention was directed by Prof. Heyrovský to the little-known Kalousek method for studying the reversibility of electrode processes. By means of a commutator, the electrode is subjected to alternate cathodic and anodic polarization at between 5 and 10 cycles/sec. In these circumstances, a metal such as zinc undergoes cyclic deposition and dissolution. In acid solution, the resultant single anodic–cathodic wave shows the reduction process to be reversible. On the other hand, the formation of a double wave in alkaline zinc solutions indicates an irreversible process.

During recent years, polarography has been successfully combined with the chromatographic technique of separation, a method known as 'chromatopolarography' having been devised by Kemula. Industrially, the polarograph is finding an ever-increasing application as a continuous service indicator. For such purposes, the mercury-pool anode is unsatisfactory, since the whole of the mercury is eventually converted to calomel. To meet this difficulty, the dropping-mercury electrode in halide solution has recently been introduced as a stable reference anode. The continuous determination of oxygen constitutes one of the more prominent examples of the continuous service application, and in this particular example the mercury-pool cathode has proved to be about a hundred times more sensitive than the dropping-mercury cathode.

An interesting biochemical application of polarography is to be seen in the apparatus of Šerák. Here, the oxygen uptake of tissue preparations can be accurately followed over a period of time. In the medical field, the polarographic diagnosis of cancer is based on Brdička's protein test, now almost twenty years old, in which, after precipitating the bulk of the proteins from the patient's serum, the filtrate is examined polarographically in the presence of hexamminocobaltic chloride in ammoniacal solution. When the patient is suffering from cancer or some feverish condition, an exceptionally large protein wave, due to muco-proteins, is observed. Prolonged experience of this test suggested that it is 80 per cent certain, but the modified test recently introduced by Balle-Helaers appears to be 100 per cent certain; this modification involves graded alkaline denaturation, before precipitating the proteins with sulphosalicylic acid.

In theoretical polarography, a new field has been opened up by Wiesner and Brdička's discovery of the kinetic current, which depends upon the rate at which depolarizer is being formed at the electrode surface. Kinetic currents are independent of reservoir height and possess temperature coefficients of the order of 30 per cent per deg. C. Such investigations have led to important information about rate-constants; for example, all four rate-constants of the mutarotation of α- and β-glucoses are derived in this manner. Brdička's study of the reduction waves of weak acids has also led to the consideration of the absolute rate of recombination of ions.

The cathode-ray oscillograph is finding increased uses in polarography. In this way, it is possible to follow the polarographic current-voltage curves on one mercury drop of 5–8 sec. duration. In an alternative approach, the potential-time curves are obtained.

THE GEOGRAPHICAL ASSOCIATION

ANNUAL CONFERENCE

THE annual conference of the Geographical Association, held at the London School of Economics and Political Science during January 3–6, was noteworthy this year for two main aspects, namely, the emphasis given to papers on London and the London Basin and the unusually large number of members who were present. All the lec-

tures were very well attended and in several cases the seating accommodation in the lecture-theatre was over-full. The annual dinner, with the president, Mr. L. S. Suggate, in the chair, attracted more members than ever before, and the excursions on the last day of the conference, though more numerous than previous years, were considerably over-subscribed.

Mr. W. F. Grimes, director of the London Museum, opened the conference with an excellent summary of the present knowledge of London's prehistory. The London theme was taken up later by a series of papers ranging from Mr. A. F. Green's fascinating analysis of the problems of London's underground drainage to Prof. S. W. Wooldridge's interesting commentary on the relationship of London's railways to the relief and structure. Dr. J. H. Bird presented a critical résumé on the activities of the London docks, and Dr. M. J. Wise analysed the role of London in the industrial geography of Britain with particular reference to the recommendations of the Barlow Commission. Both these papers were followed by excursions, one to the docks and the other to industrial areas of East London. The past and present agricultural development of the London Basin was the subject of Dr. H. C. K. Henderson's paper, which was followed by a traverse by motor coach across the northern part of the London Basin to Luton. Another excursion crossed the southern part of the basin and in the afternoon visited the National Institute of Oceanography at Wormley, near Godalming.

Teaching matters were fully discussed by Mr. Suggate in his presidential address on "Some Aspects of Teaching Geography in the Grammar School". His paper was most enthusiastically received by a very large audience, conscious of the very great contribution that Mr. Suggate has made to the development of geography in school. Another very large audience heard a stimulating and provocative paper on river development by Dr. G. H. Dury, who commented, as an examiner, on mistakes commonly found in school examination scripts. Later he took a large party of members to examine a series of river meanders in Enfield. "Sample Studies" was the title given to a meeting sponsored by the Secondary Schools Committee of the Association. The subject was introduced by Mr. R. C. Honeybone, who stressed the value of the approach as one of many ways of teaching geography in a geographical manner and outlined its pitfalls. Mr. D. J. Cadman followed this introduction by a lesson to third-form boys on the Vauxhall Works at Luton as a sample of the British automobile industry.

Prof. A. E. Smailes presented an account of the Association's summer school held last August in Aix-en-Provence; Prof. P. W. Bryan showed two films on Snowdonia and Anglesey; and Prof. A. L. Banks read a paper on what is to most geographers an unusual topic, "Some Aspects of Medical Geography". This last was a combined meeting with the Institute of British Geographers and the Royal Geographical Society, and was held at the Society's house in Kensington.

In addition to the usual large and representative publishers' exhibition, the Association's Standing Committee for Visual Aids in collaboration with the National Committee for Visual Aids in Education and the Educational Foundation for Visual Aids mounted an exhibition of sample study material, projectors and recently published film-strips.

R. C. Honeybone

THEORETICAL PHYSICS

SYMPOSIUM AT ST. ANDREWS

THE presence of Prof. **W. Heisenberg** (Göttingen) as Gifford Lecturer in the University of St. Andrews was used to organize a short, rather informal, conference on theoretical physics during November 18–20. Unfortunately, Prof. Heisenberg had to return to Germany sooner than had been expected and so, regrettably, was unable to be present, but about fifty physicists, mainly from British universities and government establishments, attended. Four sessions were held, one of which was devoted to an informal discussion on the teaching of theoretical physics.

Dr. J. Hamilton (Cambridge) introduced the first session on field theory. In view of the recent confirmation of the existence of the antiproton, his talk was devoted to an account of calculations performed in Cambridge, in conjunction with Bethe, on the possible modes of annihilation to be expected for this particle. He showed that the application of general principles of conservation of angular momentum, isobaric spin and parity is sufficient to make predictions concerning this process in the presence of very light nuclei. In general, the annihilation is expected to occur with the production of π-mesons, the ratio of π^- to π^+ to be expected depending simply on the quantum numbers of the nucleon involved.

Dr. T. H. R. Skyrme (Harwell) gave an account of a relativistic variational method for calculating the properties of a real nucleon in *PS—PS* theory, and Dr. J. S. R. Chisholm (Cardiff) reported work on the *S*-matrix in neutral pseudoscalar derivative coupling theory. Dr. J. W. Leech (Queen Mary College, London) described a method for the calculation of long-range interatomic forces; an earlier treatment of this problem by Casimir and Polder led to an inverse seventh power potential, but he finds the dependence to be an inverse third power. Dr. W. K. Burton (Glasgow) described work done in conjunction with de Borde on the method of functional integration for Fermi systems. Dr. D. L. Pursey (Edinburgh) discussed the possibility of having an acceptable theory which, although not covariant in every respect, leads only to covariant observable predictions. Finally, the session on field theory was concluded by Dr. C. G. Kuper (Liverpool), who discussed roton excitation in liquid helium.

Prof. H. A. Bethe (Cambridge and Cornell) introduced the session on nuclear physics by an appreciation of the nuclear model of Brueckner and collaborators. This model uses a generalized Hartree–Fock method and attempts, with considerable success, to deduce a self-consistent nuclear potential from the force between two free nucleons. A principal aim of the theory is to show that, using only such two-body forces, one can achieve nuclear saturation. Prof. Bethe gave an account of his own independent calculations on nuclear energy and radius, in which he has succeeded in taking complete account of the Pauli principle, and he also reported success, with Goldstone (Cambridge), in dealing with the repulsive core of the two-body nuclear potential. Preliminary numerical calculations (not taking account of the repulsive core), using a minimization procedure for the energy, show fair agreement for nuclear binding energy, but a nuclear radius one-third that of the actual radius. Proper treatment of the repulsive core,

now in progress, will certainly change both results in the right sense.

There followed four short papers, in the first of which Dr. H. Primakoff (Oxford) discussed the nuclear absorption of μ-mesons. Then Dr. R. Nataf (Edinburgh) spoke on the foundations of the Bohr–Mottelson nuclear model, and Dr. S. Dedijer (Edinburgh) analysed, in terms of the independent particle model, the similarity in the variation of binding energy of the last neutron for nuclei near carbon-12 and oxygen-16. In the last contribution to this session Prof. N. Kemmer (Edinburgh) proposed a classification of many-body forces in the lightest nuclei based on representations of the symmetric group.

The session on solid state theory was opened by Prof. M. H. L. Pryce (Bristol), who described the information obtained from studying the fine structure of the paramagnetic resonance absorption of ions such as cupric in crystals. He went on to describe the distortion of the hydration sphere of the ion which, by the Jahn–Teller effect, arises from the degeneracy of the electron wave function in a fully symmetrical environment. This degeneracy may or may not be fully removed by the distortion. If rotation about an axis remains free, the system becomes equivalent to a particle moving in an annular potential well. Prof. Pryce finally suggested an analogy between this situation and the Bohr–Mottelson model of the atomic nucleus.

Dr. E. H. Sondheimer (Queen Mary College, London) and Dr. J. M. Ziman (Cambridge) then discussed the transport of heat and electricity in solids. Dr. Sondheimer emphasized the general validity of the Onsager reciprocal relations and showed how in some treatments of thermo-electric processes algebraic obscurity has led to methods of approximation which violate these relations, while Dr. Ziman discussed the variational principle used in the solving of transport equations. Dr. N. H. March (Sheffield) described the results of some measurements of the absorption of high-frequency radio waves in semi-conductors. Dr. K. W. H. Stevens (Nottingham) discussed the construction of bonding orbitals for the first co-ordination shell in face-centred and body-centred cubic metals, and Dr. R. Fürth (Birkbeck College, London) spoke on long-range order in crystals. An account of the recombination of current carriers in a semi-conductor was then presented by Dr. P. T. Landsberg (Aberdeen), and in conclusion Dr. G. A. P. Wyllie (Glasgow) discussed the problem of diffusion at low temperatures.

On the afternoon of November 20 an informal discussion was held on the teaching of theoretical physics. After short introductory talks by Prof. Bethe, Dr. D. ter Haar (St. Andrews) and Prof. Pryce on the teaching of theoretical physics in the United States, Netherlands and United Kingdom, respectively, two topics were discussed at some length: the amount of mathematics to be taught at the undergraduate level to students who will be proceeding to do research in theoretical or experimental physics; the amount of formal teaching in physics (and possibly mathematics) to be given to research students in experimental or theoretical physics. There was a very considerable degree of agreement on the following points: that students proceeding to do research in physics should have a thorough training in pure and applied mathematics, but that this presents difficulties in many British universities owing to the rigid structure of courses and examinations; and that there should be one year with considerable formal instruction at the beginning of the period of research, and that this should be received by experimental as well as theoretical physicists. This latter point was very forcefully put by several speakers, and its need was considered sufficiently great to outweigh the disadvantage that it might occasionally extend the Ph.D. training beyond the normal three years.

J. F. Allen

CHILDREN'S FILM FOUNDATION

THE Foundation was set up in 1951 as a result of the co-operative effort of the British film industry to ensure the production, distribution and exhibition of special entertainment films for children. It began its activities in October 1951 and, during this period, has become accepted, not only in Britain but also throughout the world, as an integral part of the British film industry. It is a non-profit-making organization and is financed by grants from British Film Production Fund, Ltd.

During the four years of its existence there has been time to set a standard for the content and quality of its films and to study their reception by audiences in Great Britain as well as overseas. The steady rise in the bookings is significant of the success of Children's Film Foundation films with the audiences for whom they are made.

Since in most situations the Foundation was starting completely anew, its first films followed the conventional pattern of the 'Western'. This was necessary because children are conventional in their tastes and do not accept innovations easily. It was enough, first of all, to introduce child actors in an English background without altering the simple 'good versus bad' technique. Generally, these pictures have proved highly acceptable.

The content of the films has been gradually changed to introduce ideas of achievement above and beyond the satisfaction of catching thieves or spies. Eight achievement stories have proved as popular as the conventional adventures. The fact that the films are placed with many different companies for production helps to give the pictures vitality and variety, which add to their value in children's programmes.

Although the Foundation has not yet been able to undertake any special research project, the reception of the films is carefully recorded and studied. Besides personal observations of audiences by the officers of the Foundation, a questionnaire, returned and filled in by cinema managers, provides valuable information. There appears to be little difference in taste and response between different parts of Great Britain; but some audiences, especially in the larger cities where they are more accustomed to film-going, like the story to develop quickly; rural audiences prefer a slower pace. Individual tastes vary enormously.

What clearly emerges is the excellent natural taste of children at the cinema. They are anxious to participate in the programme and their interest is lost only by weaknesses in production, acting and, above all, in the script.

It takes time to wear down the old-fashioned idea that children go to the cinema to be excited and stimulated by violent adult action; but it is dying out in Britain. The reports of cinema managers reflect the pleasure their audiences take in films that

deal with children's problems and achievements. The only general suggestion for improving the films is the use of colour, which is costly.

The British Film Production Fund, Ltd., has made grants totalling £529,883 to the Foundation. Fundamentally, an entertainment film for children cannot be a low-priced production. Receipts from the distribution of films are now sufficient to pay for the cost of release prints, and the balance is paid to the British Film Production Fund. These receipts can never be large because admission prices to children's film shows are low. The Foundation's value to the industry and the community cannot be judged in terms of money since its primary object is to promote appreciative and intelligent film-going by youthful audiences. For this reason the British film industry as a whole supports the Foundation with an annual grant from the Fund.

FRESH WATER FROM SALT WATER

THE production of fresh water from salt water must be one of the oldest technical problems. It is currently receiving a degree of widespread yet concentrated attention which surpasses anything previously devoted to it. The reasons for this are substantially the same the world over; chief among them is the fact that living standards are rising generally and that fresh-water consumption per head of population is a basic and reliable index to the standard of living of a community. As the degree of industrialization increases and living standards rise, so does the demand for water; reservoir capacity becomes inadequate, the drain on artesian wells increases (see *Nature* of Dec. 17, p. 1133). The consequence of the latter effect depends on the situation. In coastal areas it may lead to infiltration of sea water, in other areas to a raised salt content as the increased pumping lowers the level of the underground reserve. The possibility of demineralization must be considered in both cases. For alternative sources of water one may turn, depending on one's location, to new wells, which may themselves be brackish; to new reservoir capacity, if this is feasible and if the rainfall justifies it; to more or less long-distance pumping of supplies from distant sources; or in extreme cases to sea water. All these possibilities are likely to be expensive; the first may, and the last certainly will, involve demineralization procedures.

Some indication of the interest in these procedures has been described by D. J. Neville-Jones (*Research*, 8, No. 11; November 1955). Since some publicity was given to the United Kingdom participation in the Organization for European Economic Co-operation discussions on the subject a year or two ago, scores of inquiries have been received in London from places ranging from Norway to Australia, from Hong Kong to the Bahamas. The United Kingdom itself is interested, despite its notorious rainfall, because the inexorably increasing demand is leading to sea water infiltration in such areas as the Thames Estuary; it is becoming increasingly difficult to find uncontaminated alternative sources which do not involve expensive long-distance pumping. Germany has similar problems in the lower reaches of the Rhine. The Netherlands is concerned because, by the nature of its low-lying territory, sea water infiltration is always a likely problem. Australia and South Africa are developing territories in which sea water or other highly saline waters have to be considered. The rapid industrial development of the United States of America is leading to water shortages in the vast interior territories where in many cases only brackish water is available.

The problem is not simple to define, or solve. This will depend on a multiplicity of factors such as the availability and cost of energy sources, the mineral content of the raw matter and the purpose for which the fresh water is required, that is, the price which can be paid for it. Each case will have to be examined according to the local circumstances.

LABORATORY TECHNICIANS

A SUB-COMMITTEE of the Science Masters' Association has been considering the place of laboratory technicians in secondary schools and has now issued a report. The number of schools with laboratory technicians is far too small, and there is urgent need for more technicians to be employed. This is particularly important since the problem of the recruitment of laboratory technicians in schools is related to that of the shortage of science teachers. The sub-committee suggests, however, that the establishment of a national scheme for the provision of laboratory assistance on an adequate scale to all schools where a significant amount of science is taught is a problem in its own right.

The teacher without a laboratory technician finds himself with less time than he should have for his normal teaching duties, the planning of his work and for the development of new apparatus and techniques. He has no time for designing and arranging practical work which can be carried out by the pupils themselves, and all too frequently lessons become "chalk and talk". Such a wasteful use of the time of science teachers must be deplored.

The sub-committee considers that the duties of a school laboratory technician call for a considerable degree of skill and a good deal of training. Much work has been done by various organizations on the formulation of courses of study for laboratory technicians. For schools the most suitable of these is that leading to the examination for the Laboratory Technician's Certificate of the City and Guilds of London Institute. The facilities for study are expanding; twenty-four centres, mostly technical colleges, now offer courses of instruction recognized by the City and Guilds of London Institute, and the number of candidates entering for the examination has increased from eighteen in 1951 to ninety-six in 1954.

The sub-committee realizes that recruitment is one of the most difficult parts of the problem, but believes that science teachers would be able to encourage suitable boys and girls in their own schools to apply for the posts if they could assure their pupils that salary, prospects and promotion, good working conditions—hours, holidays, superannuation, sick pay—facilities for study, and status were such as to compete with those obtainable in other educational institutions and industry.

Suggestions are also made as to the scale of assistance which might be given to various schools, suitable scales of remuneration and the duties which could be performed by laboratory technicians.

DISTRIBUTION OF 8-AZAGUANINE IN THE NUCLEIC ACIDS OF *BACILLUS CEREUS*

By Dr. R. E. F. MATTHEWS and Dr. J. D. SMITH

Agricultural Research Council Virus Research Unit, Molteno Institute, Cambridge

8-AZAGUANINE can replace a proportion of the guanine residues in the ribonucleic acids of a variety of organisms, although the amounts incorporated are low, varying from less than 1 per cent to 3 per cent of the ribonucleic acid guanine[1]. We have now found that in *Bacillus cereus*, strain 569*H*, up to 40 per cent of the ribonucleic acid guanine may be replaced by 8-azaguanine when the latter compound is supplied during growth. This is comparable to the proportion of thymine which may be replaced by halogenated pyrimidines in the deoxyribonucleic acids of *Bacterium coli* and its bacteriophages[2]. This high level of incorporation has enabled us to study the distribution of 8-azaguanine in nucleic acid preparations, relative to the normal base, and to follow the course of 8-azaguanine incorporation during bacterial growth.

Aerated cultures of *B. cereus* 569*H* were grown at 36° on the following medium: vitamin-free casein hydrolysate, 10 gm.; KH_2PO_4, 3·5 gm.; $MgSO_4.7H_2O$, 0·51 gm.; $(NH_4)_2Fe(SO_4)_2.6H_2O$, 4·8 mgm.; in 1 l. water and adjusted to *p*H 7 with sodium hydroxide. 8-Azaguanine (40 μgm./ml.) was added at a suitable bacterial density and incubation continued for 2·5 hr. The cells were then chilled, washed and frozen. Ribonucleic acid was extracted with hot *M* sodium chloride after the cells had been defatted in ethanol and acetone. Some 10–20 per cent of the total polyribonucleotide content of the bacteria was extracted by this procedure. In other experiments treatment of the cells with water (3 hr. at 50° C.) yielded about 70 per cent of the total polyribonucleotide.

Preparations or fractions of ribonucleic acid were hydrolysed in *N* potassium hydroxide to mononucleotides, which were separated by paper chromatography in *iso*propanol–water–ammonia[3] followed by electrophoresis on paper at *p*H 1·7. The spots of guanylic and 8-azaguanylic acids were eluted and estimated spectrophotometrically. (On a larger scale, 8-azaguanylic acid can be separated from guanylic acid by ion-exchange chromatography on acid 'Dowex-50' resin.) Where estimates of total ribonucleic acid content of bacteria were required (for example, Table 1), alkaline digestion was carried out on whole bacteria after extraction with hot 50 per cent ethanol.

To study the relative distributions of 8-azaguanine and guanine along the polynucleotide chains, the ribonucleic acid was digested to completion with pancreatic ribonuclease. The final products of this hydrolysis are pyrimidine mononucleotides, polynucleotides consisting of chains of one or more purine residues terminated by a pyrimidine nucleotide residue, and purine nucleoside 2′ : 3′ cyclic phosphates[3]. The purine nucleoside 2′ : 3′ cyclic phosphates can only have occupied terminal positions in the ribonucleic acid chain adjacent to a pyrimidine residue[4]. The hydrolysis products were partially separated into a number of bands in paper using the *iso*propanol/water/ammonia solvent. In this solvent compounds containing 8-azaguanine move in the same position as the corresponding guanine derivatives. The bands, in order from the starting position in the chromatogram, were eluted and the fraction of guanine residues replaced by 8-azaguanine

$$\left[\text{molar ratio } \frac{\text{(8-azaguanine)}}{\text{(8-azaguanine + guanine)}} \times 100\right]$$

measured in each. This gave the relative distribution of the two bases in polynucleotides of decreasing size.

Under conditions in which 20–23 per cent of the ribonucleic acid guanine was replaced by 8-azaguanine, enzymic hydrolysates of the bacterial deoxyribonucleic acid gave much smaller amounts of a substance with properties of 8-azaguanine deoxyriboside (less than 1 per cent of the nucleic acid guanine). Extracts of the bacteria in hot 50 per cent ethanol contained substantial amounts of 8-azaguanosine and 8-azaxanthosine, but no free 8-azaxanthine, the principal metabolite of 8-azaguanine in mammals[5] and plants[6].

Ribonuclease digestion was carried out on ribonucleic acid preparations in which 20–23 per cent of the total guanine was replaced by 8-azaguanine. The fraction of guanine replaced by 8-azaguanine was found to increase as the average size of the polynucleotides decreased, varying from 17 per cent in the largest polynucleotides to 40 per cent in the dinucleotide region. The highest 8-azaguanine content was found in the band containing only the 2′ : 3′ cyclic phosphates of guanosine and 8-azaguanosine, where 68 per cent of the residues contained 8-azaguanine.

Some fractionation of ribonucleic acid preparations can be obtained by dialysis through 'Cellophane' in *M* sodium chloride, and by precipitation with increasing concentrations of ethanol at decreasing *p*H. Using these procedures, we found that polynucleotides of smaller average size contained a greater proportion of 8-azaguanine residues relative to guanine, and also a higher proportion of 8-azaguanine 2′ : 3′ cyclic phosphate terminal groups than the whole nucleic acid preparation.

Thus the nucleic acid preparations contained a number of shorter polynucleotide chains in which a higher proportion of the guanine residues has been replaced by 8-azaguanine. From the distribution of 8-azaguanine in ribonuclease digests, replacement appears to be least in the longer sequence of purine nucleotides in the ribonucleic acid chain and greater in the shorter sequences. The very

Table 1. Replacement of 8-Azaguanine by Guanine in the Ribonucleic Acid of *B. cereus*

8-Azaguanine (50 μgm./ml.) was added to cultures 1 and 2 at zero time. After 30 min., guanine (25 μgm./ml.) was added to culture 2

Time after addition of 8-azaguanine	Molar ratio $\frac{\text{(8-azaguanine)}}{\text{(8-azaguanine+guanine)}} \times 100$ in bacterial ribonucleic acid		Relative amounts of ribonucleic acid in the cultures (based on D_{260} mμ of ribonucleotides after hydrolysis)	
	Culture 1	Culture 2	Culture 1	Culture 2
30 min.	13·5	13·5	2·62	2·62
60 min.	16·9	7·7	3·13	3·16
120 min.	28·2	4·0	3·76	5·66

high proportion of 8-azaguanosine 2′ : 3′ cyclic phosphate terminal residues in the nucleic acid could be explained by assuming that an 8-azaguanine residue in this position makes the further addition of nucleotide residues along the chain less likely. Alternatively, the 2′ : 3′ cyclic phosphate termination may have some special significance in ribonucleic acid turn-over.

The inhibition of bacterial growth by 8-azaguanine and the incorporation of the latter into ribonucleic acid may be annulled by supplying guanine. We have followed the disappearance of 8-azaguanine from the ribonucleic acid as the growth-rate is restored. 8-Azaguanine disappears much more rapidly than can be accounted for by dilution of existing ribonucleic acid by new ribonucleic acid without 8-azaguanine (Table 1). These results suggest either a rapid degradation and resynthesis of polynucleotides, or an exchange reaction in which bases can be replaced without breakdown of the polynucleotide chain.

We wish to thank Dr. Martin Pollock for the strain of *B. cereus* and the Medical Research Council Unit for Research in Antibiotics, Clevedon, for a large-scale preparation of this organism.

[Nov. 10

[1] Matthews, R. E. F., *J. Gen. Microbiol.*, **10**, 521 (1954). Lasnitzki, I., Matthews, R. E. F., and Smith, J. D., *Nature*, **173**, 346 (1954).
[2] Dunn, D. B., and Smith, J. D., *Nature*, **176**, 305 (1954). Zamenhof, S., and Griboff, G., *Nature*, **176**, 305 (1954).
[3] Markham, R., and Smith, J. D., *Biochem. J.*, **52**, 558 (1952).
[4] Markham, R., and Smith, J. D., *Biochem. J.*, **52**, 565 (1952).
[5] Mandel, H. G., Alpen, E. L., Winters, W. D., and Smith, P. K., *J. Biol. Chem.*, **63**, 193 (1951).
[6] Matthews, R. E. F., and Smith, J. D., "Advances in Virus Research", **3**, 49.

VARIATIONS IN THE AMOUNT OF FEULGEN STAIN IN NUCLEI OF PLANTS GROWN AT DIFFERENT TEMPERATURES

By Dr. L. F. La Cour
John Innes Horticultural Institution, Bayfordbury, Hertford, Herts
AND
Dr. E. M. Deeley and Dr. J. Chayen
Wheatstone Physics Laboratory, King's College, London

It has long been known that growth at low temperature induces a linear differentiation in the metaphase chromosomes of certain plant species[1-3]. At temperatures ranging from −1° C. to +5° C., depending on the species, specific weakly Feulgen-staining segments appear which are constant in length and position. It was shown from a study in various plant species that such segments correspond to the condensed and frequently fused heterochromatic segments observable in telophase and interphase nuclei[1,3,4].

The weak reaction of heterochromatic segments in metaphases from plants grown in the cold was attributed to 'nucleic acid starvation'. This interpretation implies that low temperature, by retarding the synthesis of deoxyribonucleic acid, leads to the chromosomes entering mitosis with eu- and heterochromatic regions competing for a depleted supply of deoxyribonucleic acid. Antagonism to this view has grown with the recent wide acceptance of the concept that the amount of deoxyribonucleic acid per haploid chromosome set is constant[5,6].

The present study is part of an attempt to reinvestigate this phenomenon quantitatively by measuring Feulgen staining photometrically by means of a scanning densitometer devised by Deeley[7]. This was used in conjunction with a cell-crushing technique which enables measurements to be made at all phases of the mitotic cycle[8]. The accuracy of the scanning instrument has been demonstrated by a series of measurements made on Feulgen-stained sperm heads and cells of the onion root meristem, which show that the readings obtained are, in fact, proportional to the amount of stain present, to an accuracy of the order of ± 3 per cent for this type of material[7].

Plant species with and without detectable heterochromatin were investigated. Roots were removed and fixed after the potted plant had been kept at the control temperature (19°–20° C.) for at least four days. The plant was then subjected to the cold conditions; other roots were removed from it and

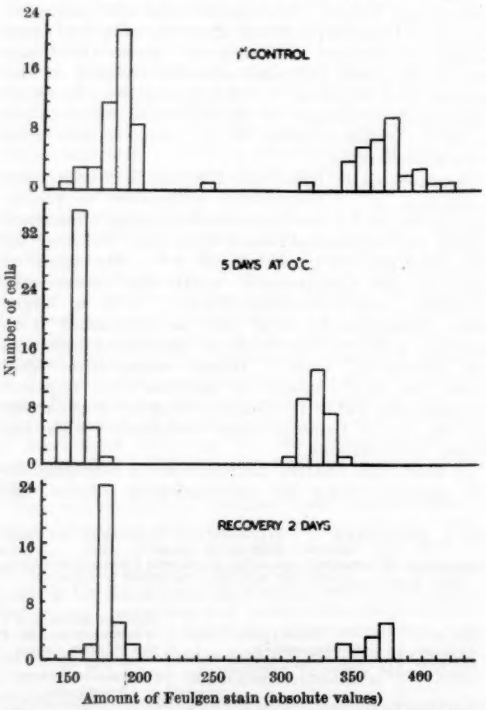


Fig. 1. Measurements of total Feulgen stain in mitotic nuclei of *Trillium grandiflorum*, showing the alteration in values obtained according to temperature conditions of plant growth. From root meristems of a plant kept at 19°–20° C. for four days, after five days at 0° C. and after return to 19°–20° C. for two days

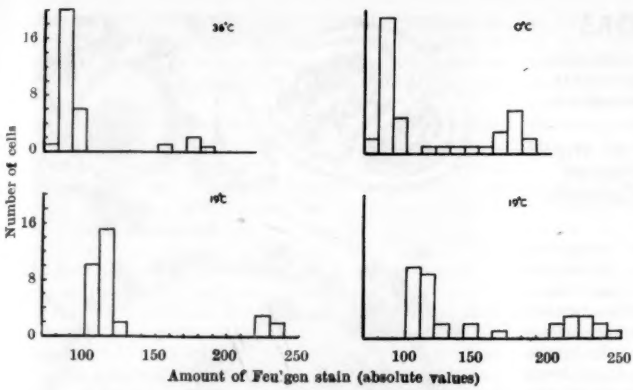


Fig. 2. Measurements of total Feulgen stain in mitotic nuclei from root meristems of *Scilla campanulata*, showing the similarity of values in two plants kept at 19° C. and the similar reduction obtained in them at two extremes of temperature

fixed at suitable intervals of time and the plant was returned to recover under the control conditions. It was thus possible to have controls from the same plant both before and after treatment.

Fixation, hydrolysis and staining were strictly the same for control and treated roots. Since all specimens from any one experiment were stained by the Feulgen reaction and measured at the same time, the first control roots had to be stored in 70 per cent alcohol in a refrigerator for a longer time than those grown in the cold. This was shown to have no effect on the final measurements, since identical results were recorded for the control roots taken before and after the cold treatment. All phases of the mitotic cycle were examined.

Six main facts have emerged from these initial observations. First, as recorded for animal tissues (cf. ref. 6), $2C$ and $4C$ values, depending on the stage of chromosome division and duplication of deoxyribonucleic acid, were obtained in nuclei from roots of plants kept at the control temperature. Thus telophase and most of the interphase nuclei had the $2C$ amount of Feulgen stain, whereas prophase, metaphase and some interphase nuclei contained twice this quantity; a few interphase nuclei had intermediate values. Secondly, smaller values of $2C$ and $4C$ were found in nuclei from plants kept for three to five days at low temperature. This reduction appeared in nuclei at all stages of mitosis irrespective of whether the species contained detectable heterochromatin or not (Table 1 and Fig. 1). Thirdly, the threshold temperature required for inducing these changed values varied with the species. This was clearly shown by the difference between *Scilla campanulata* and *S. sibirica*, where $-1°$ and $-6°$ C. respectively were required to reduce values for Feulgen staining (Table 1). Fourthly, comparable reductions to those in the root meristem were encountered in the resting nuclei of the differentiated zone. Fifthly, there was a return to normality in cells about to enter mitosis, and also in those of the differentiated zone, after cold-treated plants were returned to the control temperature (Fig. 1).

Finally, as shown in one experiment in which two plants of *Scilla campanulata* were used, high temperature can apparently cause a reduction of the value of C comparable to that obtained by cold (Fig. 2). It will be noted that the amounts of Feulgen stain in nuclei of roots taken from these two plants at the beginning of the experiment were identical.

We feel caution is required in interpreting these results. The simplest explanation would be that the decrease in the amount of Feulgen stain in the nuclei of roots grown at low temperature represented a true reduction of the deoxyribonucleic acid content. This would imply that the comparable loss in the resting differentiated nuclei represented the breakdown half of a deoxyribonucleic acid turnover cycle, the synthesis of the deoxyribonucleic acid being reduced. Until this interpretation can be confirmed by other means, however, it is necessary to recognize an alternative explanation, namely, that the change in temperature might alter the reactivity of the deoxyribonucleic acid to the Feulgen stain. No obvious mechanism can be suggested by which this could be effected by low temperature during growth and which would yet allow the deoxyribonucleic acid to be fully normal 48 hr. after the plant had been returned to control conditions. Furthermore, the fact that different temperatures were necessary to induce this effect in different species makes this interpretation appear somewhat unlikely.

We wish to thank Prof. J. T. Randall for his interest in the study and Dr. H. B. Fell for her helpful criticism of the manuscript. One of us (L. F. La Cour) is grateful for the provision of working facilities in the Wheatstone Physics Laboratory; E. M. Deeley and J. Chayen wish to acknowledge support from the Nuffield Foundation and the British Empire Cancer Campaign, respectively.

[Nov. 16

Table 1. Effect of Temperature on the Feulgen Staining of Plant Nuclei

Plants examined	Treatment	Results
Species with heterochromatin		
Paris polyphylla	5 days at zero (0° C.)	20 per cent reduction
Trillium grandiflorum	3 ,, ,, ,,	10 ,, ,,
,, ,,	3 ,, ,, ,,	15 ,, ,,
,, ,,	5 ,, ,, ,,	20 ,, ,,
Scilla sibirica	3 days at −1° C.	No reduction
,, ,,	5 ,, −6° C.	15 per cent reduction
Species with no detectable heterochromatin		
Scilla campanulata	3 days at −1° C. (identical control temp.)	23 per cent reduction
	2 ,, 36° C.	23 ,, ,,
Bellevalia romana	3 ,, −1° C.	20 ,, ,,
Fritillaria pallidiflora	3 ,, −1° C.	25 ,, ,,

1 Darlington, C. D., and La Cour, L. F., *J. Genet.*, **40**, 185 (1940).
2 Darlington, C. D., and La Cour, L. F., *J. Hered.*, **32**, 115 (1941).
3 Geitler, L., *Chromosoma*, **1**, 554 (1940).
4 La Cour, L. F., *Heredity*, **5**, 37 (1951).
5 White, M. J. D., "Animal Cytology and Evolution", 2nd edit. (Camb. Univ. Press, 1954).
6 Swift, H., *Int. Rev. Cytology*, **2**, 1 (Academic Press, Inc., N.Y., 1953).
7 Deeley, E. M., *Scientific Instruments*, **32**, 263 (1955).
8 Davies, H. G., Wilkins, M. H. F., and Boddy, R. G. H. B., *Exp. Cell Res.*, **6**, 550 (1954).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

An Electron Microscopical Study of the Histochemical Localization of Alkaline Phosphatase in the Cell Wall of *Chlorella vulgaris*

In algae it is considered that the oxidative assimilation of hexose follows the same glycolytic pathway as in higher organisms, and that these substances after dephosphorylation yield hexose phosphate, which may be used in polysaccharide synthesis, or enter the metabolic pool[1]. Enzymes that may take part in these processes have been shown by biochemical methods to be present on the cell surfaces of small organisms, such as yeast[2]. However, the limitations in resolution of the light microscope have made it difficult to demonstrate such enzymes histochemically, especially as regards their exact localization relative to the cell wall.

In this work, an attempt has been made to apply histochemical methods for observation with the electron microscope, thus increasing the possibilities of a more accurate localization due to the higher resolution of this instrument[3].

The material used in these experiments, *Chlorella vulgaris*, was transferred from agar slope to a liquid mineral medium and centrifuge-washed several times in distilled water. The centrifugate was then dispersed in Gomori's mixture for alkaline phosphatase, where it was incubated for periods of time ranging from 15 min. to 2 hr. It was then centrifuged in distilled water and treated with 0·5 per cent silver nitrate solution, centrifuge-washed in distilled water, fixed in 1 per cent osmium tetroxide vapour, dehydrated in graded alcohols and embedded in methacrylate. Ultra-thin sections were cut with the Sjöstrand microtome for examination in the electron microscope.

Material treated as above, up to the alcohols, was spray-mounted on 'Formvar'-coated grids and examined directly with the electron microscope.

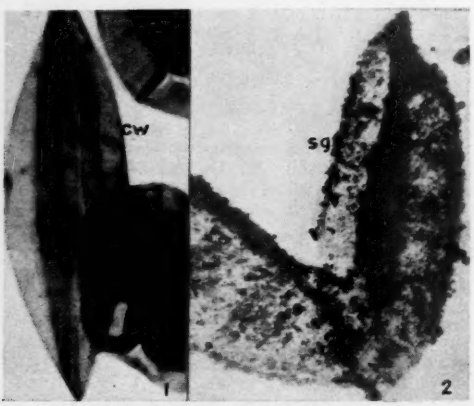


Fig. 1. Spray-mounted whole cell. × 4,000. *cw*, cell wall

Fig. 2. Spray-mounted whole cell preparation. Incubated in Gomori's substrate for alkaline phosphatase. Positive reaction shows as dense granules of various sizes deposited on the cell wall. × 4,000. *sg*, silver granules

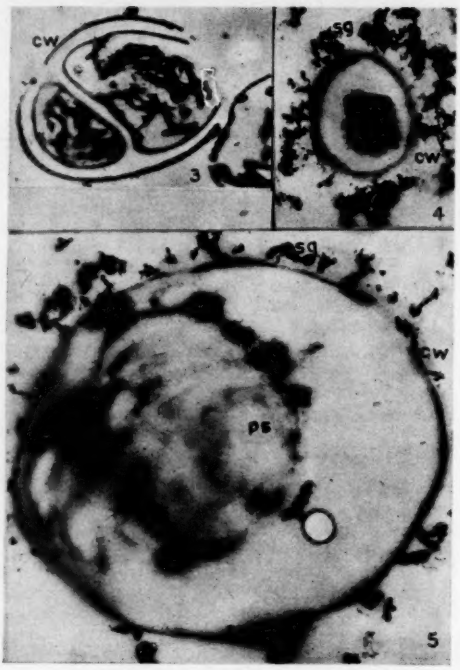


Fig. 3. Ultra-thin specimen section of control specimen. Note small number of granules on the cell wall. × 4,000. *cw*, cell wall

Fig. 4. Ultra-thin section of specimen incubated in Gomori's substrate for alkaline phosphatase. The positive reaction shows as a dense aggregate of silver granules partly attached to the cell wall. × 4,000. *cw*, cell wall; *sg*, silver granules

Fig. 5. Ultra-thin section of specimen incubated in Gomori's substrate for alkaline phosphatase. The positive reaction appears as an aggregate of dense granules of silver attached to the cell wall. × 7,000. *cw*, cell wall; *sg*, silver granules; *ps*, protoplasmic structures

Controls were run by treating the tissues in the same way except that the glycerophosphate was omitted from the incubation mixture. Sections were also made from material fixed in osmium tetroxide vapour, dehydrated in alcohols and embedded in methacrylate.

The von Kóssa method for showing up the calcium phosphate formed as a result of enzymatic action suggested the detection of silver phosphate at the sites of reaction; silver phosphate is readily visible in electron micrographs as a dense granular precipitate.

Fig. 1 shows the electron micrograph of untreated spray-mounted specimens. Fig. 2 shows the electron micrographs of spray-mounted specimens incubated in Gomori's mixture. The positive reaction is indicated by dense granules, presumably of silver phosphate, unevenly distributed on the cell wall. The cell wall appears as a denser band at the edges. However, this picture does not show the relationship between the silver precipitate and the cell structures.

Fig. 3 shows an ultra-thin section of the cell of the control material. Very few granules, of whatever origin, are present. This might be due to the unspecific deposit of the silver present in the control incubation medium. Figs. 4 and 5 are electron micrographs of ultra-thin sections of cells incubated in Gomori's medium. Here the positive reaction is marked by dense granules attached to the outer

surface of the cell wall. These granules appear as particles of various sizes and in different degrees of aggregation. There also appears to be some reaction in relation to the structures present in the cell interior.

The histochemical demonstration of alkaline phosphatase has been subjected to critical experimental analysis by Danielli[4]. The rather short period of incubation and the fact that the incubation was carried out prior to fixation provide the optimum conditions for minimizing artefacts. The present results tend to confirm previous biochemical determinations which have indicated the presence of enzymes on the cell surface in other organisms[2].

In our preparations the apparent lack of contact, in many places, between the silver precipitate and the cell surface, can perhaps be explained by the fact that the material was centrifuged with forces up to 7,000 *g* at least eight times after the precipitate had been formed. The heavy metal particles, under these conditions, would be expected to separate somewhat from the cell wall. As can be seen in the preparations of spray-mounted, unsectioned specimens, the particles of silver seem to be more closely associated with the cell wall. This may be accounted for by the fact that no centrifugal force was applied after the silver precipitate was formed. In considering the weak reaction observed inside the cell, it is necessary to bear in mind that the cells have been incubated intact in the Gomori substrate, and that the possibility exists that the substrate might not have been able to penetrate the cell membrane into the protoplast structures.

The pure culture of *Chlorella vulgaris* used was obtained through the courtesy of Dr. G. E. Fogg, Botany Department, University College, London.

This work was carried out at the Anatomiska Institutionen, Karolinska Institutet, Stockholm, while we were guests of F. S. Sjöstrand, to whom our thanks are due.

D. Brandes

Comisión Nacional de la Energía Atómica,
División Investigaciones Radiobiológicas,
Argentina.

R. N. Elston

Anatomiska Institutionen,
Karolinska Institutet,
Stockholm,
Sweden.
Dec. 8.

[1] Fogg, G. E., "The Metabolism of Algae", 6 (Methuen, London, 1953).
[2] Rothstein, A., and Meier, R. C., *J. Cell Comp., Physiol.*, **32**, 77 (1948).
[3] Brandes, D., Zetterqvist, H., and Sheldon, H., *Nature* (in the press).
[4] Danielli, J. F., "Cytochemistry" (Wiley, New York, 1953).

Analysis of Crystalline Hæmoglobin Derivatives by Paramagnetic Resonance

The investigation of single crystals of hæmoglobin derivatives by paramagnetic resonance can give two distinct types of information. First, the actual resonance conditions and the resultant *g* values associated with the electronic transitions will yield details on the orbitals involved in the chemical binding of the central iron atom. Secondly, the angular variation of the *g* values enables an accurate determination to be made of the orientation of the hæm and porphyrin planes with respect to the external crystalline axes. Although the structure of the rest of the molecule cannot be analysed directly in this way, detailed information on the orientation of the hæm planes can be combined with X-ray measurements[1] to calculate the polypeptide chain directions and similar factors. It would appear that the determination of the hæm plane orientations by paramagnetic resonance is much more accurate than that by any other method so far applied.

The main experimental limitation in such an investigation is the relatively small size of the crystals available, and for this reason all the measurements are made at 20° K. with a low-temperature resonator[2] and at frequencies of 25,000 Mc./s. or 36,000 Mc./s. When studying angular variation the electromagnet is rotated around the resonator, and the field positions of the absorption line plotted against angle of rotation. The first derivative studied in detail was whale acid–met myoglobin, as this was available in the form of large single crystals. The results obtained from this are a good illustration of the two types of information that can be obtained by paramagnetic resonance.

First the magnitude of the *g* value associated with the single electronic transition was found to vary from a $g_\perp = 5{\cdot}95 \pm 0{\cdot}05$ to a $g_\parallel = 2{\cdot}00 \pm 0{\cdot}01$. As previously noted[3], the occurrence of such a wide *g* value variation can be explained by assuming that $S = \pm \frac{5}{2}$ and that the lowest doublet is $Sz = \pm \frac{1}{2}$ with a zero-field splitting to the other spin doublets much greater than that of the microwave quanta (> 2 cm.$^{-1}$). This splitting is far larger than that encountered in other ferric salts, and shows that the charge distribution on the surrounding atoms has a much greater effect than in normal ionic binding.

Secondly, the angular variation of the *g* value can be used for locating the axis through the iron atom perpendicular to the hæm plane, since this direction corresponds to the $g_\parallel$ of 2·0. This determination is based on the fact that, with axial symmetry, the *g* value at any angle θ from the axis is given by $g^2 = g_\parallel{}^2 \cos^2\theta + g_\perp{}^2 \sin^2\theta$, or, in the case of these derivatives, $\sin^2\theta = \frac{1}{5}\left(\frac{g^2}{4} - 1\right)$. By rotation in the *ab*, *bc* and *ac* crystallographic planes, the direction of the minimum *g* value in these planes can be located, and from its magnitude the angle which the parallel axis makes with the particular crystallographic plane can be calculated. Sperm-whale myoglobin crystallizes in two different types *A* and *B* [1,4], and the results of measurements on both types are given in Table 1, in the form of the direction cosines for the axis through the iron atom perpendicular to the hæm plane.

Table 1

Crystal type	Crystal symmetry	Direction cosines of axis		
		L	*M*	*N*
A	$P2_1$	0·89	0·36	0·28
B	$P2_12_12_1$	0·13	0·95	0·29

The acid–met derivative is only one of many that can be investigated in this way, and these large loosely packed organic crystals have the advantage that individual crystals can be directly converted to other derivatives without loss of form. Thus an acid–met crystal can be immersed in a solution of sodium azide for a controlled time and then removed with half the crystal as an azide derivative and half still as an acid–met derivative. This technique is very useful since the previously analysed spectrum of the latter can then be used as a check on the orientation

and g-value symmetry of the new derivative. In this way it can be shown that the g value of the azide derivative varies from a maximum $g_\perp$ of $2{\cdot}8 \pm 0{\cdot}05$ to a $g_{\parallel}$ of $1{\cdot}70 \pm 0{\cdot}05$, with considerable distortion of axial symmetry. The occurrence of a single electronic transition with g values spread across the free-spin value indicates that the binding is of the d^2sp^3 type, leaving one unpaired spin with some orbital admixture, similar to the case of potassium ferricyanide[5].

Further measurements are in progress on other derivatives and with hæmoglobin and myoglobin of different species, to obtain as much detailed information as possible on the binding of the iron atom and the orientation of the hæm planes. We would like to thank Dr. J. C. Kendrew for supplying the single crystals.

J. E. Bennett
D. J. E. Ingram

University of Southampton.
Jan. 5.

[1] Kendrew, J. C., *Acta Cryst.*, **1**, 336 (1948).
[2] Ingram, D. J. E., "Spectroscopy at Radio and Microwave Frequencies", 66 (Butterworths, Ltd., 1955).
[3] Griffith, J. S., and Stevens, K. W. H., as quoted in George, P., Bennett, J. E., and Ingram, D. J. E., *J. Chem. Phys.* (in the press).
[4] Kendrew, J. C., Parrish, R. G., Marrack, J. R., and Orleans, E. S., *Nature*, **174**, 946 (1954).
[5] Bleaney, B., and Ingram, D. J. E., *Proc. Phys. Soc.*, A, **65**, 953 (1952).

Spectrophotometric Method for the Estimation of Vitamin K_3

Reddy and Srinivasan[1] have described a method for the estimation of vitamin K and vitamin K_3 which is slightly different from that of Novelli[2]. During the course of our investigation on the biosynthesis of vitamin K in moulds, we found that the method of Reddy and Srinivasan was not suitable for determining microquantities of vitamin K. It was observed that, on standing, the intensity of the colour at the junction of the two layers increases, with the result that the intensity of colour is not uniform throughout the layer. In the present communication, we wish to describe a modified method which can be used to estimate vitamin K in the range 2–30 μgm.

Vitamin K_3 solution (2–30 μgm.; 2-methyl-1,4-naphthoquinone) was shaken with 0·5 ml. of ethyl alcohol and to this was added 0·1 ml. of a saturated solution of 2 : 4-dinitrophenyl hydrazine in 2 *N* hydrochloric acid. After 10 min., 0·25 ml. of 20 per cent sodium carbonate was added and shaken well until the green colour appeared. 3 ml. of amyl alcohol, 1 ml. of ethyl alcohol and 1 ml. of water were added, shaken thoroughly and kept for 5 min. for the salts to go down. The amyl alcohol layer was taken and the density read at 635 mμ in a Beckman model *DU* spectrophotometer (1 cm. light-path). The colour obtained in this method is stable for 10 hr. Distilled ethyl and amyl alcohol were used throughout this investigation. Fig. 1 gives the relation between the optical density (Δ 635 and the concentration of vitamin K_3).

Details of the application of this method to estimate microquantities of vitamin K in moulds will be described elsewhere.

Vanamala Sathe
J. B. Dave
C. V. Ramakrishnan

Department of Biochemistry,
Faculty of Science,
M.S. University of Baroda,
Baroda.

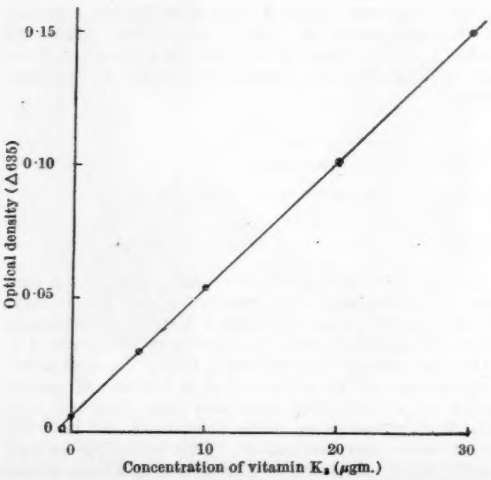


Fig. 1. Effect of concentration of vitamin K_3 on colour development

[1] Reddy, D. V. S., and Srinivasan, V., *Curr. Sci.*, **17**, 22 (1948).
[2] Novelli, A., *Science*, **93**, 358 (1941).

The 'Queen-Substance' of Honeybees and the Ovary-inhibiting Hormone of Crustaceans

In the course of work on the social organization of honeybee communities[1], it has been found that worker honeybees obtain a substance ('queen-substance') from their queens which, if obtained in sufficient quantity, inhibits development of their ovaries and the production of further queens. It will also, under experimental conditions, inhibit ovary development in worker ants (*Formica fusca*) (unpublished work, C. G. B.). A similar hormone has been shown to inhibit ovary development in decapod crustaceans[2]. These substances appear to be similar in several respects. Thus both are stable to heat and to acids but less so to alkalis, soluble in acetone and alcohol, both are active, at least under certain conditions, when taken orally, and both serve to inhibit development of the ovary and related phenomena.

We decided, therefore, that it might prove of interest to administer honeybee queen-substance to prawns and also the ovary-inhibiting hormone of prawns to bees. The results of preliminary experiments are now available.

The queen-substance from a single mated queen honeybee (*Apis mellifera* L.) was extracted in alcohol. This extract was mixed with water, a little palmitic acid added, the *p*H adjusted to 6·2 and the alcohol and excess water distilled off. A control emulsion was prepared in the same way starting with alcohol alone.

Three groups, each consisting of twelve female prawns, were used. The prawns in group I remained intact and received no injections. The eye-stalks of the prawns in group II were severed, thus removing

Table 1

Condition and treatment of animals	Mean weight of ovaries (mgm.)	Histological condition of ovaries
(I) Intact; received no injection	4·90±0·65	All fully regressed; no commencement of vitellogenesis
(II) Eyestalks removed; control emulsion injected	17·67±3·39	All with well-developed yolk-droplets. One ovary full of yolk and showing dark green, ripe colour
(III) Eyestalks removed; honey-bee queen-substance injected	6·56±0·72	Some yolk-droplets present in a few cells in each ovary

the ovary-inhibiting hormone, and on the following day each of these prawns received an injection of 0·08 ml. of the control (alcohol) emulsion. The prawns belonging to group III had their eyestalks removed, and on the following day 0·08 ml. of the experimental (alcohol + honeybee queen-substance) emulsion was injected into each. This experiment was carried out at the time of year when most ovary-inhibiting hormone is present in the eyestalks of prawns and their ovaries are fully regressed. In such circumstances, removal of eyestalks normally leads to rapid ovary development.

One week after injection the surviving prawns—nine in each group—were killed and their ovaries weighed and examined histologically (Table 1).

The results show that removal of the eyestalks of the prawns forming the controls (group II) resulted in development of their ovaries and that, since there is a significant difference ($P < 0·001$) between the degree of ovary development in the prawns in group II and III, a single injection of honeybee queen-substance has produced a strong but incomplete inhibition of ovary development.

In the reciprocal experiment, twenty sinus glands—the organ in the eyestalks of crustaceans in which the ovary-inhibiting hormone is stored[2]—were removed from female prawns (*Leander serratus*) and their contents were dispersed by means of a Potter homogenizer in 67 per cent sucrose syrup. This syrup was then incorporated in a pollen-candy mixture and fed continuously to newly emerged bees kept in a cage at 31° C. and supplied with drinking water. Another group of newly emerged bees, the controls, were kept similarly but fed on a pollen-candy mixture without the addition of sinus-gland contents.

After nineteen days it was determined whether the ovaries of each bee had developed or had remained undeveloped as they would have done in the presence of a queen (Table 2).

It is clear that there is a highly significant difference ($P < 0·001$) in the degree of development of the ovaries of the bees of these two groups, and it appears that the sinus-gland extract of prawns has inhibited ovary development in worker honeybees.

Table 2

	Treatment	No. of bees with ovaries developed	No. of bees with ovaries undeveloped
Control group	Fed pollen-candy mixture	30	4
Experimental group	Fed pollen-candy mixture + prawn sinus-gland contents	15	17

To the similarities which we have observed between the queen-substance of honeybees and the ovary-inhibiting hormone of prawns may now be added a reciprocity of action. It seems probable that these two substances are the same or related compounds, possibly steroids, and occur in a number of arthropods.

David B. Carlisle

Marine Biological Laboratory,
Plymouth

Colin G. Butler

Bee Department,
Rothamsted Experimental Station,
Harpenden.

[1] Butler, C. G., *Trans. Roy. Ent. Soc., Lond.*, **105**, 11 (1954).
[2] Carlisle, D. B., *Publ. Staz. Zool. Napoli*, **24**, 355 (1953).

An Erythrocyte Sphering Factor in Rat and Mouse Plasma

When suspensions of many types of mammalian red cells in saline media are examined between a glass slide and coverslip, the cells change their shape from biconcave disks, through a stage of crenation, to spheres[1]. This change is associated with the removal or inactivation of an anti-sphering factor normally present in plasma albumin[2].

Recently, Trotter[3] in this laboratory has demonstrated the great importance of contamination of glassware by some substance, possibly a fatty acid, present on human skin. A single handling of a clean cloth used for wiping slides or coverslips contaminates both the cloth and the glassware and causes sphering. If the contaminated glassware is flamed, however, red cells retain their disk-like form. This finding makes it possible to observe the action of sphering agents without the presence of plasma or albumin. We have found that the plasma of several common varieties of laboratory rats appear to contain a substance which will cause sphering of saline suspensions of human cells between flamed slides and coverslips. This is in marked contrast to the behaviour of the plasma of the ox, pig, sheep and man as well as purified bovine or human plasma albumin, which not only have no sphering action but on the contrary prevent sphering on unflamed slides and protect the cells against substances such as sodium oleate, which cause sphering. In fact, the spheres observed in rat plasma can be changed back into disks by the addition of sufficient human plasma. The sphering activity of rat plasma is quite high; one part of rat plasma diluted with four parts of 2 per cent human albumin causes complete sphering and one part in twenty causes crenation of all cells and some sphering.

Rat plasma causes sphering of the cells of several other species including the rabbit and cat. There is no sphering action on rat cells, or on mouse cells, though the latter may become cupped. Human plasma does not cause crenation or sphering of rat cells, though cupping may occur (in our experience cupping seems to be a common reaction of the red cells of one species to the plasma of another; but we found no reference to this in the literature). Plasma from common laboratory mice behaved similarly to that from the rat, though the activity was rather less. Plasma from the vole, wild Orkney mouse, hamster and rabbit all caused crenation, but not complete sphering, while guinea pig plasma seemed to be quite inactive. The effect is thus not universal among rodents. We have sometimes

observed that the sphering activity appears to increase if the plasma is left to stand for some hours at room temperature. Sphering activity has not been observed in the plasma of other common animals though the number investigated is comparatively small.

Indirect evidence suggests that the sphering agent may be a fatty acid. It is possibly significant that Robinson *et al.*[4] have found that rat plasma contains an active lipolytic system which brings about the dissolution of chylomicrons with the release of free fatty acids. No explanation can yet be offered of why the rat cells do not become spherical in their own plasma.

We wish to thank Dr. D. S. Robinson for useful discussions and the Rockefeller Foundation for financial assistance. This work was aided by a personal grant (F. M. G.) from the Medical Research Council.

R. Barer
F. M. Gaffney

Department of Human Anatomy,
University Museum,
Oxford.
Sept. 9.

[1] Hamburger, H. J., *Pflüger's Arch.*, **141**, 230 (1895).
[2] Furchgott, R. F., and Ponder, E., *J. Exp. Biol.*, **17**, 117 (1940); Ponder, E., "Hemolysis and Related Phenomena" (Churchill, London, 1948).
[3] Trotter, W. D., D.Phil. Thesis, Oxford (1954); *Brit. J. Haematol.* (in the press).
[4] Robinson, D. S., Jeffries, G. H., and French, J. E., *J. Exp. Physiol.*, **39**, 165 (1954).

A Method for determining the Duration of Action of the Cardiac Glycosides

The determination of the duration of action of the cardiac glycosides has depended mainly on toxicity experiments which require large numbers of animals. The Hatcher method[1] depends on the difference between the usual lethal dose of a suitable cardiac glycoside and the actual dose required to kill at various times after the administration of the cardiac glycoside under test. Another method developed by Hauptstein[2] makes use of the relationship between the rate of infusion and the toxic dose of a cardiac glycoside; the decrease in toxicity with slow rates of infusion indicates the degree of elimination (detoxification and excretion). Data on the duration of action are also available from clinical records, where the criterion for the persistence of cardiac activity after the administration of a cardiac glycoside can be electrocardiographic changes such as alteration of the *T*-wave or decrease in heart-rate, or the therapeutic effect, although this is difficult to evaluate precisely.

A property of the cardiac glycosides has recently been described by Rand, Stafford and Thorp[3], which can be adapted for the study of the duration of action of cardiac glycosides and related compounds, particularly short-term changes seen with certain rapidly metabolized drugs of this group. The action of injected adenosine on the guinea pig heart (a transient period of partial heart-block) is markedly potentiated by doses of cardiac glycoside which alone are too small to have any observable effect on the electrocardiograph. The degree of potentiation appears to depend on the amount of digitalis drug available to the heart.

Injections of adenosine are made at regular intervals, and then a dose of the cardiac glycoside under test is given. The change in duration of the period of heart-block produced by adenosine injections gives an indication of the activity of the cardiac glycoside. (The technical details have been described by Rand *et al.*[3]). With a single injection of digoxin, the potentiation of the adenosine effect persists for longer than three hours with no indication of any decrease, whereas a single injection of digoxigenin produces only a transient increase in the duration of the adenosine heart-block. Typical experiments are shown graphically in Fig. 1. It can be seen that a higher dose of digoxigenin is required to produce the same degree of potentiation as digoxin, reflecting the lower toxicity of this compound in the guinea pig. The rate of dissipation of digoxigenin can be calculated as the time for the response to adenosine to return to its previous level after giving the digoxigenin. From the results given in Fig. 1 the rate of elimination of digoxigenin is approximately 1·5 mgm./kgm./hr. for the high dose and 1·0 mgm./kgm./hr. for the lower dose. Hoffman and Lendle[4] found a value of 1·0–2·0 mgm./kgm./hr. for the elimination of digitoxigenin in the guinea pig using a slow infusion method.

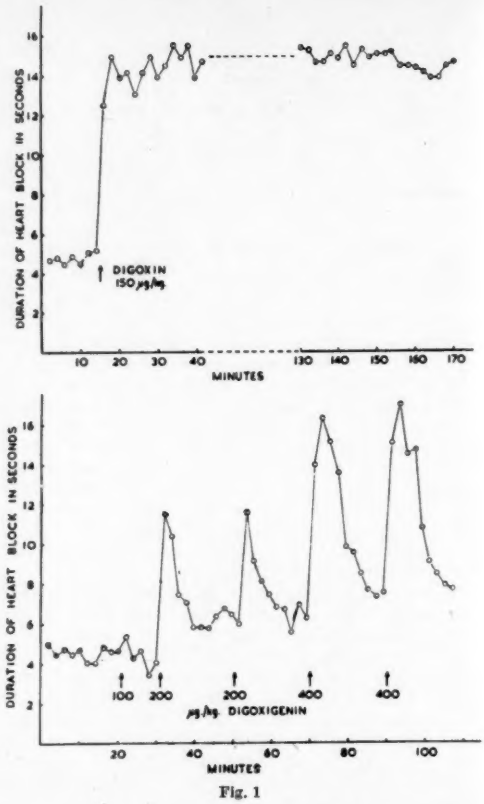


Fig. 1

A study of the rate of elimination of a number of other cardiac glycosides and genins and their synthetic derivatives is in progress, together with experiments on the role of hepatic and renal mechanisms in their elimination.

We are indebted to Prof. R. H. Thorp for his interest and encouragement during the course of this work, and to Mr. S. E. Wright, of the Pharmacy

Section, for supplying a chromatographically pure sample of digoxigenin.

M. Rand*
Anne Stafford†

Department of Pharmacology,
University of Sydney,
N.S.W.
Sept. 27.

* Drug Houses of Australia Research Fellow.
† Burroughs Wellcome and Co. (Aust.), Ltd., Research Fellow.

[1] Hatcher, R. A., *Arch. Int. Med.*, **10**, 268 (1912); *J. Amer. Med. Assoc.*, **61**, 386 (1913).
[2] Hauptstein, P., *Arch. Exp. Path. Pharmak.*, **126**, 121 (1927).
[3] Rand, M., Stafford, A., and Thorp, R. H., *J. Pharmacol.*, **114**, 119 (1955).
[4] Hoffman, G., and Lendle, L., *Arch. Exp. Path. Pharmak.*, **212**, 376 (1951).

Biosynthesis of Fatty Acids by Seeds of *Ricinus communis*

So far, the biosynthesis of fatty acids in plant material seems to have received little attention; in this connexion we notice especially the communications of Newcomb and Stumpf[1]. We have now taken up similar researches on seeds of *Ricinus communis* var. *sanguineus*. The seeds were germinated in moist sand at 30° C. in darkness, the cotyledons sliced with a thin razor blade by freehand into sections ± 0·5 mm. thick, and aliquots incubated in water and substrate in a Warburg apparatus for 6 hr. at 30° C. After incubation the slices were rinsed and extracted with a mixture of ethanol–ether (3 : 1); evaporation *in vacuo* leads to pure castor oil. After saponification, the non-saponifiable material was extracted with petroleum–ether. The fatty-acid fraction was acidified, extracted several times and the combined ether-fractions dried and evaporated.

An aliquot of the fatty acids was subjected to chromatographic fractionation by the method of Howard and Martin[2]; ricinoleic acid, because of its alcoholic function, had a different solubility and passed the column as a $C_8 - C_{10}$ fatty acid (see also J. Boldingh[3]). With acetate as substrate, the respiratory quotient was ± 0·85; with propionate it was a little higher; without substrate, it was lower than 0·85. The latter fact is due to a higher oxygen consumption. The concentration of the substrates was 0·01 *N*.

Although incubation of the slices with ^{14}C-1 acetate (± 0·15 mgm.) reveals an important conversion of the ^{14}C-1 acetate to carbon dioxide, a considerable part was metabolized and incorporated into fatty acids. This fact confirms again that acetate is an important precursor of the fatty acids in seeds.

Separation of the acids by urea complexes[4] showed that the ricinoleic acid fraction, containing 70 per cent of the total fatty acid content, possessed practically no radioactivity; the remaining fraction,

Table 1. Fractionation of Castor Oil (^{14}C-1 Acetate as Substrate)

Fatty acid	Specific activity (counts/min.)	Total activity	Acetate incorporated × 100
Ricinoleic acid (72·2%)	0·6	180·4	0·39
C_{12} acid (3·0%)	10·8	136·1	0·30
C_{14} acid (2·6%)	41·8	451·4	0·98
C_{16} acid (4·5%)	48·7	920·4	2·0
C_{18} acid (17·7%)	126·8	9,357·9	20·4
Non-saponifiable material	550·0	715·0	1·5

Table 2. Fractionation of Castor Oil (^{14}C-1 Acetate and Glucose as Substrate)

Fatty acid	Specific activity (counts/min.)	Total activity	Acetate incorporated × 100
Ricinoleic acid (64·9%)	0·7	203·8	0·44
C_{12} acid (2·3%)	15·0	157·6	0·34
C_{14} acid (5·1%)	59·7	1,386·4	3·01
C_{16} acid (12·9%)	250·1	13,668·5	29·83
C_{18} acid (14·8%)	79·4	5,257·3	11·47
Non-saponifiable material	818·0	1,554·2	3·4

containing the saturated and unsaturated fatty acids, was highly active. Fractionation of radioactive castor oil by the method of Howard and Martin confirmed these results and proved that the ^{14}C-1 acetate was incorporated mainly into the C_{18} fatty acid (Table 1).

Addition of glucose (conc. 0·01 *N*) to the ^{14}C-1 acetate substrate reduced respiratory quotient during several hours of the experiment, by diminution of the exhaled carbon dioxide, but it stimulated the incorporation of acetate into the fatty acids at a considerable rate. Fractionation of castor oil carried out in this way shows that: (1) the percentage of stearic acids and ricinoleic acid is lowered in favour of the C_{14} and C_{16} acids. (2) The radioactivity is transported to the C_{18} fraction (see Table 2).

The non-saponifiable material possessed, contrary to the results of Newcomb and Stumpf, considerable radioactivity. This indicates that acetate might play a part in the biosynthesis of phytosterols.

Our results on the influence of glucose may be explained by assuming that glucose acts as an acetate 'sparer'. The question remains open whether glucose is an active precursor of glycerol, and whether the removal of the fatty acids, as triglycerides, from the metabolic pool, is limited by the amount of glycerol available.

These experiments illustrate also the possibility of free metabolites influencing the lipid metabolism of germinating seeds.

N. Coppens

Pharmaceutical Institute and
Laboratory of Physical Biochemistry,
University of Ghent.
Sept. 23.

[1] Newcomb, E. H., and Stumpf, P. K., *J. Biol. Chem.*, **200**, 233 (1953). Humphreys, T. E., Newcomb, E. H., Bokman, Ann H., and Stumpf, P. K., *J. Biol. Chem.*, **210**, 941 (1954). Stumpf, P. K., *Plant Physiol.*, **30**, 55 (1955). Humphreys, T. E., and Stumpf, P. K., *J. Biol. Chem.*, **213**, 941 (1955).
[2] Howard, G. A., and Martin, A. J. P., *Biochem. J.*, **48**, 532 (1950).
[3] Boldingh, J., *Rec. des Trav. des Pays-Bas*, **69**, 247 (1950).
[4] Knafo, G., *Bull. mens. inform. ITERG*, **7**, 291 (1953).

A Synthetic Growth Medium for the Trypanosomid Flagellate *Strigomonas* (*Herpetomonas*) *oncopelti*

Biochemical studies of the Trypanosomidae have been delayed by the difficulties encountered in cultivation and maintenance of many species. Up to the present time, only one member of this family (*Herpetomonas culicidarum*) has been cultivated in a defined medium[1], and this was of a degree of complexity comparable to that required by the most exacting bacteria. The present communication describes a simple synthetic medium which will support the growth of the parasitic flagellate *Strigomonas oncopelti*; this trypanosomid, first isolated in bacteria-free culture by Noguchi and

Table 1. A Synthetic Growth Medium for the Parasitic Flagellate *Strigomonas oncopelti*

	(mgm.)		(gm.)
Methionine	200·0	Glucose	5·0
Adenine	10·0	NH_4Cl	5·0
Thiamine	1·0	$Na_2HPO_4.2H_2O$	0·25
Nicotinamide	1·0	KH_2PO_4	0·08
Ca pantothenate	1·0	NaCl	9·0
Pyridoxine hydrochloride	1·0	KCl	0·42
p-Aminobenzoic acid	1·0		
Biotin	0·01		
Trace metal solution*	10 ml.		

Glass-distilled water to 1 litre.
Initial *p*H value, 7·2. Medium sterilized by autoclaving at 10 lb. pressure for 10 min.

* Trace metal solution: $MgSO_4.7H_2O$, 20·0 gm.; $FeSO_4$, 0·5 gm.; $ZnSO_4.7H_2O$, 0·5 gm.; $MnSO_4.3H_2O$, 0·5 gm.; $CuSO_4.5H_2O$, 0·5 gm., made up to 1 litre in *N*/10 sulphuric acid.

Tilden[2] in 1926, is parasitic in the digestive tract of Hemiptera and in latex plants. Lwoff[3] reported that *Strigomonas oncopelti* could be cultivated in alkaline hydrolysates of silk or in certain peptones if these were supplemented with thiamine; in contrast to other trypanosomids, it does not require hæmatin as a growth factor.

The nutritional requirements of *Strigomonas oncopelti* have been determined in a synthetic medium according to the general method of Gladstone[4]. A complete medium which would support the growth of the flagellate was prepared containing twenty-one amino-acids, eight growth-factors, purines, pyrimidines, glucose, ammonium chloride, sodium and potassium phosphates and trace metals. Further batches of media were prepared to test the effect of omission of the above components either singly or in groups. Cells to be used as inocula in growth tests were grown in the complete medium for 24 hr. at 25° C. and were washed three times in the medium to be tested; a standard inoculum of 2×10^5 cells/ml. growth-medium was used in all cases.

Results showed that the amino-acid requirement of this organism could be satisfied by methionine alone; adenine was also required for growth in addition to the growth factors thiamine and nicotinamide. In a glucose – salts medium containing these additions, growth was slow, the organisms having a mean generation-time of more than 24 hr.; the further addition of biotin, pyridoxin, pantothenic acid and *p*-aminobenzoic acid more than doubled the growth-rate, and cells reached a final density of about 4×10^7/ml. ($\equiv$ 0·4 mgm. dry weight cells/ml.). *Strigomonas oncopelti* has now been maintained on this medium for more than six months, being subcultured at intervals of three to four days; the detailed composition of the medium is given in Table 1. This is the simplest medium yet recorded for the growth of a parasitic flagellate, and it is interesting to note that *Strigomonas oncopelti*, although a parasite of Hemiptera and latex plants, is considerably less exacting nutritionally than the free-living ciliate *Tetrahymena pyriformis*[5].

So far as I am aware, there is no account in the literature of the cultivation of any member of the Trypanosomidae on solid media, Protozoa of this group usually being cultivated on complex diphasic media. *Strigomonas oncopelti* grows readily on a solid medium prepared by adding 0·7 per cent (w/v) agar to the synthetic medium described; discrete colonies are visible after four days incubation at 25° C. and cultures can be kept for three to four weeks without loss of viability.

The development of a synthetic medium for *Strigomonas oncopelti* permits for the first time a detailed study of the biosynthetic capabilities of an actively growing trypanosomid. Experiments using the synthetic medium described, supplemented with tracer amounts of acetate labelled with carbon-14, have shown that 50 per cent of the acetate carbon is fixed in the lipid fraction of logarithmically growing cells, 35 per cent is located in the cell protein (the use of methyl- and carboxyl-labelled acetate indicates that both carbons are utilized for the synthesis of glutamic and aspartic acids, alanine, threonine, tyrosine, lysine, arginine, valine, proline, phenylalanine and the leucines), and the remaining 15 per cent is distributed equally between the acid-soluble cell constituents and the nucleic acid fraction. These and other results, which will be reported in detail elsewhere, are similar to those obtained by McQuillen and Roberts[6], who studied the utilization of acetate for synthesis in *Escherichia coli*, and may be interpreted in terms of the Krebs tricarboxylic-acid cycle functioning in actively growing *Strigomonas oncopelti*.

B. A. Newton

Medical Research Council
Unit for Chemical Microbiology,
Biochemical Laboratory,
University of Cambridge.
Nov. 16.

[1] Cowperthwaite, J., Weber, M. M., Packer, L., and Hutner, S. H., *Ann. N.Y. Acad. Sci.*, **56**, 972 (1953).
[2] Noguchi, H., and Tilden, E. B., *J. Exp. Med.*, **44**, 307 (1926).
[3] Lwoff, M., *C.R. Soc. Biol.*, **126**, 771 (1937).
[4] Gladstone, G. P., *Brit. J. Exp. Path.*, **18**, 322 (1937).
[5] Kidder, G. W., and Dewey, V. C., in Lwoff, "Biochemistry and Physiology of Protozoa", **1**, 323 (Acad. Press, Inc., New York, 1951).
[6] McQuillen, K., and Roberts, R. B., *J. Biol. Chem.*, **207**, 81 (1954).

Resolution by means of a Micro-organism of Racemic Diaminosuccinic Acid and Determination of its Configuration

The chemical structure of diaminosuccinic acid is analogous to aspartic acid, asparagine, C_4-dicarboxylic acids and the other biologically important substances. The acid, however, has not yet been found in Nature, and so has never been fully investigated. In 1925, racemic acid was resolved into its antipodes by Kuhn[1], through the morphine salt of N,N′-dibenzoyl diaminosuccinic acid; $[\alpha]_D^{20} = -18{\cdot}9°$ (10 per cent hydrochloric acid). Suzuki and Suzuki[2] found, during the course of an investigation on the behaviour of micro-organisms towards the acid, that *Micrococcus ureae* was capable of growing on a medium containing the racemic acid as the sole source of nitrogen, and that about half the amount of racemic acid always remained even after full growth. From these observations the authors considered that the micro-organism preferentially assimilated one of the two optical isomers, and that a non-utilizable antipode could perhaps be isolated from the medium.

(1) *Synthesis of Racemic Diaminosuccinic Acid.* The acid was prepared by the reduction of dioxytartaric acid phenylosazone in the following manner, which was a modification of Farchy's method[3], since, in our hands, it gave more satisfactory results. A powder of 100 gm. of the osazone was resolved in 1 litre of 2 per cent sodium hydroxide with 1 kgm. of cracked ice, and 4 kgm. of sodium amalgam (2·5 per cent) was added to the solution; the mixture was stirred for 1 hr. At the end of the reaction, 167 gm. of 30 per cent sulphuric acid was slowly added (the temperature rising to 40° C.), and after stirring for

an additional hour, the mixture was filtered. The filtrate was decolorized with the continuous extraction of ether, and when it was acidified with sulphuric acid to *p*H 2, the meso-isomer precipitated. After the precipitate was filtered off, the filtrate was adjusted to *p*H 5 with sodium carbonate. It was necessary for the complete precipitation of the racemic acid to keep the solution for a week at 0° C. The crude preparation was purified by recrystallizations from aqueous hydrochloric acid as well as Farchy's method, and dried over phosphorus pentoxide *in vacuo*; the yield was 13 gm. The racemic acid contained one mole of water.

Analysis. Calc. for $C_4H_8O_4N_2.H_2O$: N, 16·86; found: N, 16·90 per cent. Melting point of N,N'-dibenzoyl-diaminosuccinic acid, 162° C. R_F values by paper chromatography (ascending method): *n*-BuOH/AcOH/H_2O (4 : 1 : 1), 0·04; phenol saturated with water, 0·11.

(2) *Culture and Extraction.* *Micrococcus ureae* was incubated at 30° C. with shaking in the following medium: distilled water, 1 litre; glucose, 10 gm.; sodium citrate, 2 gm.; dipotassium hydrogen phosphate, 1 gm.; ammonium chloride, 0·5 gm.; DL-diaminosuccinic acid, 0·5 gm.; crys. magnesium sulphate, 0·1 gm.; sodium chloride, 0·1 gm.; potassium dihydrogen phosphate, 0·1 gm.; *p*H adjusted to 7·0 with sodium hydroxide. After 24 hr., the culture solution was added with trichloracetic acid, and deproteinized by centrifuging. The supernatant was adjusted to *p*H 5 and concentrated to one-twentieth of the first volume by vacuum distillation. Diaminosuccinic acid was obtained as crude crystals by keeping the concentrated solution in an ice-box for one week. It was purified by recrystallizations from aqueous hydrochloric acid and dried over phosphorus pentoxide *in vacuo*; the yield was 40 per cent of racemic acid. Its nitrogen content, melting point of dibenzoyl derivative and R_F values were identical with those of the racemic acid.

(3) *pH-Change of the Specific Rotation.* The rotatory power of this preparation of diaminosuccinic acid was measured in solutions of sodium hydroxide and hydrochloric acid of various concentrations. Table 1 shows that the specific rotation was at a maximum in neutral solution, and successive additions of acid or alkali to it resulted in a lævorotatory shift. It is well known that the specific rotation of amino-acids varies decidedly with the *p*H of the solution, and that unnatural amino-acids (D-configuration) show maximum dextrorotatory power in neutral solutions, whereas natural amino-acids (L-configuration) show maximum lævorotatory power in these solutions[4]. Therefore it is concluded that the configuration of this antipode belongs to the *D*-series.

Table 1. SPECIFIC ROTATION OF D-DIAMINOSUCCINIC ACID AT VARIOUS SODIUM HYDROXIDE OR HYDROCHLORIC ACID CONCENTRATIONS

Moles of sodium hydroxide or hydrochloric acid per mole diaminosuccinic acid in the solution		Specific rotation* $[\alpha]_D^{20}$
NaOH	65·1	− 2·84
	38·9	− 4·96
	19·4	− 9·04
	10·8	− 13·40
	1·1	+ 5·47
HCl	4·7	+ 32·20
	9·8	+ 16·70
	20·1	− 0·65
	47·0	− 4·36
	250·0	− 16·80

* Measured by a Landolt-type polarimeter (0·01°) with 1-decimetre tube.

(4) *Racemization of* D-*Diaminosuccinic Acid by Benzoylation.* In order to measure the specific rotation of N,N'-dibenzoyl-D-diaminosuccinic acid, it was benzoylated by Kuhn's method using benzoyl chloride and sodium bicarbonate; the reaction was run at 25° C. for 2 hr. The specific rotation of the benzoyl derivative thus prepared (melting point, 162° C.) was

$$[\alpha]_D^{20} = +0{\cdot}019\,\frac{100}{1{\cdot}004\times 1{\cdot}693} = +1{\cdot}12°.$$

Since the specific rotation of the same substance obtained by chemical resolution[1] was + 106·5°, it is evident that our preparation had been racemized through this procedure.

We thank Prof. F. Egami, of Nagoya University, for his interest and encouragement.

SAKARU SUZUKI
HISAO MAKISHIMA
NOBORU SUZUKI

Department of General Education,
Nagoya University,
Nagoya.
Sept. 30.

[1] Kuhn, R., and Zumstein, F., *Ber.*, **58**, 1429 (1925); **59**, 479 (1926).
[2] Suzuki, S., Suzuki, N., and Egami, F., *J. Biochem., Japan*, **39**, 305 (1952). Suzuki, S., and Suzuki, N. (unpublished).
[3] Farchy, I. M., and Tafel, J., *Ber.*, **26**, 1985 (1893).
[4] Lutz, O., and Jirgensons, B., *Ber.*, **63**, 448 (1930); **64**, 1221 (1931); **65**, 784 (1932).

Separation of Unstable Oxidation Intermediates of Cysteine

THE recent emergence of new bio-functional thiol compounds (coenzyme-A, lipoic acid) has revived interest in the series of compounds which represent oxidation-levels intermediate between —SH and —SO_3H.

We therefore wish to record an observation made some time ago in connexion with paper chromato-

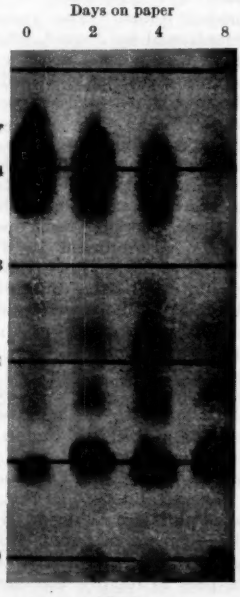


Fig. 1

graphic experiments[1], which suggests a simple technique for visualization and separation of unstable oxidation products. In order to evaluate the stability of cysteine in paper chromatography, we applied, on different days, to *S. & S.* 589 *GR* paper four spots of 10λ, each of which contained 80μ of cysteine hydrochloride in 3 *N* hydrochloric acid in 50 per cent formic acid. When the last spot had dried, the paper was developed with phenol/*iso*propanol/water[1] and treated with ninhydrin. Fig. 1 shows the results. From left to right, the spots have been 'ageing' on the paper for 0, 2, 4 and 8 days before development. This is accompanied by a steady decrease of cysteine (R_F 0·4) and a steady increase of cystine (R_F 0·1, and probably in non-ionized form at R_F 0). In addition, intermediates, that is, compounds which pass through a time-maximum, are seen at R_F 0·16 and 0·23, and perhaps at 0·27. Discreteness of the spots and absence of tailing indicate that they represent a record of oxidative events occurring on the fibre surface in the 'dry' spots, and that little, if any, changes occur during the solvent-run. The possibilities of detecting and isolating unstable oxidation intermediates by these means are obvious.

G. Toennies
J. J. Kolb
Lankenau Hospital Research Institute and
Institute for Cancer Research,
Philadelphia 11, Pa.
Sept. 21.

[1] Toennies, G., and Kolb, J. J., *Anal. Chem.*, **23**, 823 (1951).

Insect Mobility and Design of Field Experiments

Recent papers have stressed two of the problems that arise in the design of field trials when insecticides are employed. McKinlay[1] noted that the protection of a crop afforded by the use of insecticide may be partially vitiated by re-invasion of insects from adjacent unsprayed plots. The converse of this situation was mentioned by Joyce[2], who pointed out that in the Sudan Gezira "the insect regime on unsprayed cotton may have been [so] affected by the wide-scale application of insecticide upon surrounding cotton".

A population of a mobile species is conceived to be in dynamic balance, numbers lost by emigration being replaced by immigration. When the distribution of a population has been affected by the application of insecticides, these two processes operate side by side to modify the environment in which sprayed and unsprayed crops grow. An important consequence of this modification can be the diminution of differences of yield expected between sprayed and unsprayed plots. By recolonization, the yield of a sprayed plot may be diminished; but following the action suggested by Joyce[2], the yield of a control plot may secondarily be increased by a drain of insects from the control to the sprayed plots.

Entomological opinion in the Sudan Gezira leans to the view that areas sprayed with DDT act as traps into which the nymphs and adults of *Empoasca libyca* de Berg migrate and die. In this way, populations upon control plots are reduced. By local usage, this postulated movement of jassids from unsprayed areas is termed an 'interplot effect' and connotes the ability of a plot to modify the character of the insect population upon an adjacent cropping area.

Recolonization by jassids of a previously sprayed area at Tokar as an example of interplot effect has been examined by Goodman (unpublished results). The inward movements of *Empoasca* nymphs from unsprayed cotton could be detected two weeks after spraying, though it is probable that continuous invasion occurred at all times after this date. The invasion was noticed first at the periphery of the sprayed plot, and the subsequent rates of build-up of nymphal populations were significantly correlated ($P = 2$ per cent) with the distance of the sampling station from the sprayed/unsprayed interface.

The influence of sprayed areas in reducing populations of jassids infesting adjacent unsprayed cotton was elucidated recently. The experimental unit consisted of two observation rows of *X*1730*A* cotton surrounded on each side by five rows of the same variety. These outer ten rows were sprayed on a number of occasions, but the jassid counts were made only upon the unsprayed central observation rows, which were protected during spraying by temporary hessian screens. There were ten replicated subplots for each treatment, each subplot having an area of 350 sq. metres.

In Table 1 are shown the total numbers of jassid nymphs counted from fifty leaves per subplot on eight occasions between October 13 and November 27, 1954. Using the log n transformation, analysis of variance of the total nymphs counted per plot showed that significant differences of population existed between the numbers of nymphs on the control subplots (that is, observation rows surrounded by unsprayed cotton), and the numbers counted on observation rows surrounded by cotton sprayed one or more times.

Table 1. Total Recorded Population of Nymphs on 50 Leaves per Subplot for 8 Occasions

Surrounds sprayed	Total population on observation rows per subplot (log means)
Control	2·3299
1×	2·0975, 2·1830
2× : 3×	1·9229, 1·9762 : 1·9354, 1·8786
4×	1·7095, 1·7764, 1·7855

Least sig. diff. $P = 5$ per cent (as log) 0·1358.

That is to say, the presence of plots sprayed with DDT adjacent to unsprayed areas of cotton significantly reduced the infestation of cotton jassid upon these untreated plots. Four applications of DDT produced a greater effect upon populations on nearby unsprayed areas than did fewer applications.

This evidence is important because, where large areas of cotton are sprayed each year, as in the Sudan Gezira, the apparent benefit from DDT spraying may be considerably less than expected; indeed, may fail to reach significance level, owing to the operation of interplot effects, although other tests may show that the destruction of the cotton jassid significantly improves yields.

The interplot effect demonstrated in the case of the cotton jassid has wide implications; indeed, the concept appears in different guises and has many applications in applied entomology. Thus Pearson[4] notes both the beneficial and disadvantageous aspects of this effect in respect of the protection against *Heliothis armigera* Hb. afforded by well- or ill-timed successions of maize and leguminous crops. De Bach and Bartlett[5], in North America, showed that sprayed citrus trees trap and poison immigrant *Vedalia*

beetles which prey on various immobile scales on citrus. In the Sudan Gezira, numbers of cotton whitefly are reduced by the activities of several species of parasites and predators. The latter are mobile whereas the immature stages of their host on which they feed are immobile. It is possible that numbers of whitefly in unsprayed fields adjacent to sprayed ones may be increased by the loss of parasites and predators moving into sprayed fields. This aspect of interplot effect has also received attention because, if shown to be real, it would result in a general lowering of level of yields on sprayed and unsprayed fields alike, and give rise to differences in yields between sprayed and unsprayed fields which are spurious even were such differences statistically significant.

These, and other aspects of interplot effect, are being investigated by workers in this department, and it is hoped shortly to publish more extensive results on this important aspect of the biology of pests of cotton. I thank the Chief of the Research Division, Sudan Government, for permission to publish this preliminary communication.

R. J. V. Joyce

Entomology Section,
Gezira Research Farm,
Research Division, Ministry of Agriculture,
Sudan Government.
Sept. 19.

[1] McKinlay, K. S., *Nature*, **171**, 658 (1953).
[2] Joyce, R. J. V., *F.A.O. Plant Prot. Bull.*, 3 (6), 86 (1955).
[3] Joyce, R. J. V., Ann. Rep. of Res. Div., Min. of Agric., Sudan Govt., 1949–50, p. 92.
[4] Pearson, E. O., Proc. 6th Symp. Colston Res. Soc., Univ. Bristol Pub. (Butterworth, London, 1954).
[5] De Bach, P., and Bartlett, B., *J. Econ. Ent.*, **44**, 373 (1951).

A Combinatorial Design for Experiments with Alternative Responses

Often an easily recognizable symptom of disorder, for example, chlorosis, appears in plants. If the reason is not obvious and a nutritional origin is suspected, nutrient elements are applied in one way or another to find which is deficient, results being judged on the qualitative response of a 'yes' or 'no' type. Usually, every suspected element is applied in a separate treatment, say, as an injection (if trees are concerned) or a spray. At least as many solutions (or more generally, kinds of treatment) are then needed as there are elements to try. The same is obviously true if each treatment supplies all but one of the elements considered. The number of treatments, the many solutions, and the cleaning of injection or spray apparatus with the care necessary in trace-element work, make the operations tedious and cumbersome. If the area under study is remote and inaccessible, difficulties become serious.

There exists, however, at least in the exploratory stage of inquiry, a theoretical possibility of obtaining the same amount of information from a number of treatments substantially smaller than the number of elements used. To demonstrate the principle with the simplest possible example, let us take two solutions: solution I contains iron and zinc; solution II, iron and magnesium. If only solution I brings about improvement, we conclude that zinc is deficient; if only solution II works, it is magnesium; if both I and II work, it is iron. Here with only two solutions we obtain information about three elements. Of course, the gain is small in this case.

Quite generally, an element can be distributed among n different solutions (treatments) in 2^n different ways. This number includes a 'distribution' consisting of absence from all n solutions. Actually, then, only $2^n - 1$ elements can be arranged between n solutions in such a way that each element will be present in a different combination of solutions. The combination of solutions that bring about the disappearance of the abnormal symptom defines the element responsible, because elements and combinations are in a biunique correspondence.

It follows that in an experiment with three solutions, seven elements can be used. One element will be present in all three solutions; of three elements, each will be in one of the three possible pairs of solutions: I and II, I and III, II and III; and three elements will each be in one only of the three solutions: I, II or III. Metals must be used as salts, so the element forming the common anion, for example, sulphur, will usually occupy the combination of all solutions. Similarly, four solutions provide for fifteen elements, which is about the maximum needed in the present state of our knowledge about plant nutrition.

Controls or plants not treated with any of the elements will, as a rule, be an essential part of the experimental scheme. Thus, strictly speaking, with $n + 1$ variants of treatment, we obtain information about $2^n - 1$ elements.

For conclusions from an experiment of this kind to be valid, the following conditions seem especially important: (*a*) the deficiency is simple: the deficiency of only one element is the cause of the visible abnormal symptom; (*b*) the remedy is unique: only the application of the deficient element improves the condition, no other element does; (*c*) there are no interactions: each element acts in the same way whether any other element is present in the treatment or not.

In practice, condition (*a*) will be satisfied in most cases, condition (*b*) nearly so. Condition (*c*), on which knowledge is scarcest, arouses most doubt.

In spite of these limitations, the idea seems to merit submission for discussion and trial by students of this branch of plant physiology and, indeed, by all those who work with experimental arrangements where the conditions of alternative response ('yes' or 'no'), simplicity, uniqueness and independence (*c*) can be assumed to prevail.

K. Strzemieński

Soil Bureau,
Wellington,
New Zealand.
July 29.

Relationship between Photosynthesis and a Homogeneous Protein Component of Plant Cytoplasm

Ultracentrifuged analyses by Wildman and co-workers[1,2] of cytoplasmic protein of leaf cells of a number of higher plants, extracted by mechanical disruption of cells into buffer, have revealed two major fractions: the first a homogeneous component of sedimentation constant (S_{20}) 16–18 Svedberg units (fraction 1) and the second a polydisperse component with mean S_{20} of 3–4 units (fraction II).

These observations have recently been extended to a number of pasture plants[3], and the presence of similar components confirmed in the leaves of monocotyledons as well as dicotyledons. Fraction II displays a number of enzymic activities[4], whereas the biochemical function of fraction I has not been elucidated.

To determine further the distribution of these two components, a brief series of experiments was carried out. The soluble proteins derived from tissues of seedlings of monocotyledons were analysed in the ultracentrifuge. In the first group, seeds of wheat and Italian rye-grass were germinated and suspended over trays of nutrient solution, where they grew in normal daylight until the first leaf was fully formed. The proteins were extracted from both leaves and roots, as well as from the leaves of albino mutants which are produced by about 1 per cent of the seed. The albino character is believed to be controlled by a single recessive gene.

In the second group, wheat seedlings were grown in the dark on moist cloth until the etiolated leaf was just emerging from the elongated coleoptile. A number of shoots were dissected into leaf and coleoptile tissue, and the remainder exposed to 4,000 ft.-candles at 60° F., further shoots being removed and dissected after various periods.

In the third group, the growth of etiolated wheat seedlings was prolonged by supplying adequate mineral nutrients and sucrose as energy source until the leaf, still in etiolated form, had completely emerged from the coleoptile and could be readily harvested. In a similar fashion the growth of seedlings, in which the first leaf had completely emerged in light, was prolonged in the dark for a further ten days, and the first leaves harvested.

The amount of fraction I calculated per 100 parts of fraction II in the extracts from these various tissues is summarized in Table 1. This method of presentation is adopted because of the difficulty of finding a suitable criterion for tissues of such widely different type and composition. The results suggest that fraction I is found only in photosynthesizing tissue or in tissue which is capable of photosynthesis after it is exposed to light. In the experiments with etiolated plants, the rapidity of leaf development after exposure to light partly obscures the formation of fraction I in existing tissue; but the low level in relatively mature etiolated leaves, and the disappearance from normal leaf on transfer to the dark indicate that the fraction reaches full development only when active photosynthesis is taking place.

Table 1

Tissue	Conditions of growth	Amount of fraction I per 100 parts fraction II
1. Wheat leaf	Full light, 7 days	66
2. Wheat root	,, ,, ,, ,,	Nil
3. Rye-grass leaf	,, ,, ,, ,,	61
4. Rye-grass root	,, ,, ,, ,,	Nil
5. Albino rye-grass leaf	,, ,, ,, ,,	Nil
6. Wheat seedling leaf	Dark, 5 days	18
7. ,, ,, ,,	,, ,, ,, + 5 hours light	23
8. ,, ,, ,,	,, ,, ,, + 12 ,, ,,	29
9. ,, ,, ,,	,, ,, ,, + 20 ,, ,,	52
10. Wheat seedling coleoptile	,, ,, ,, + 20 ,, ,,	Nil
11. Wheat seedling leaf	Dark, 10 days	32
12. ,, ,, ,,	Full light, 7 days; dark, 10 days*	16

* During growth in dark, second leaf developed in etiolated form, but only first leaf, which had matured during growth in light, was analysed.

This association of fraction I with photosynthesis may prove to be merely coincidental; but as the part it plays in cell metabolism is not yet known, its connexion with photosynthesis is worth further study.

J. W. Lyttleton

Grasslands Division,
Palmerston North,
New Zealand.

[3] Singer, S. J., Eggman, L., Campbell, J. M., and Wildman, S. G., *J. Biol. Chem.*, **197**, 244 (1952).
[3] Eggman, L., Singer, S. J., and Wildman, S. G., *J. Biol. Chem.*, **205**, 969 (1953).
[3] Lyttleton, J., *Biochem. J.* (In the press).
[4] Wildman, S. G., and Jagendorf, A., *Ann. Rev. Plant Physiol.*, **3**, 131 (1952).

A Simple Method of assessing the Moisture exuded through the Skin of Cattle

To assess the moisture, use is made of the Assman psychrometer with the addition of a simple and easily made adaptation, which consists of a square polished metal box 4 in. × 4 in. × 2½ in., open at one end. Two holes, sufficiently large to hold the box against the air tubes by means of the threaded ends of the psychrometer cups, are punched in the closed end of the box, equidistant from the sides. In the middle of the bottom edge of each side a ½-in. square cut is made, and when the box is fitted over the psychrometer cups, the instrument is ready for use on livestock.

It is recommended that the wick of the wet-bulb thermometer of the psychrometer be examined frequently during a period of experiment to guard against its becoming dry. The wick should be discarded after thirty animal readings as dust particles from the skin of the animals are likely to cling to the moist surface, thereby impairing the efficiency of the instrument.

Air humidity is measured at a distance of 3 ft. from each animal and level with its back. The skin humidity is then taken from a site on the left side of the animal, over the last rib and as close to the vertebral column as possible, ensuring that the box is flat against the skin. The hair on the site chosen is clipped close to the skin, and the readings are taken at exactly 90 sec., both for atmospheric and animal measurements. In an initial experiment (see Table 1),

Table 1

Animal	Mile	Atmospheric dew point	Animal dew point	Ratio of animal dew point to atmospheric dew point	Skin temperature	Atmospheric temperature
261	0	57	60	1·05	86·4	65·3
296	0	57	58	1·02	87·6	66·0
300	0	57	57	1·00	83·5	67·1
261	1	59	60	1·02	86·2	85·8
296	1	57	59	1·04	90·9	86·9
300	1	58	58	1·00	85·8	79·7
261	2	56	58	1·04	93·0	83·3
296	2	57	61	1·07	92·3	81·5
300	2	57	58	1·02	94·5	86·9
261	4	54	55	1·02	96·1	87·8
296	4	54	57	1·06	94·8	79·7
300	4	53	61	1·15	97·3	88·7
261	7	50	58	1·16	99·3	82·4
296	7	50	58	1·16	98·8	88·7
300	7	52	57	1·10	100·6	89·6

skin temperatures on the same site were taken using a thermistor thermometer (kindly supplied by Dr. Findlay of the Hannah Dairy Research Institute, Kirkhill, Scotland). Unshaded atmospheric temperatures were also recorded at each time of measurement.

All wet- and dry-bulb readings were expressed as 'dew point', and it is suggested that a convenient method of expressing the difference between atmospheric humidity and the humidity of the air passing close to the skin of the animal would be the ratio of the animal dew point to the atmospheric dew point. Figures calculated on this basis are included in Table 1, which shows the results of readings taken on three mature Tanganyika zebu bulls which were walked a measured distance around an open paddock. Readings were taken before walking commenced and at 1 mile, 2 miles, 4 miles and 7 miles. Walking commenced at 08.00 hr., and approximately four minutes elapsed between measurements relating to each animal at the various distances.

The animals were not allowed to graze until after the seventh mile. The results in Table 1 show that the instrument is capable of demonstrating minor fluctuations in moisture exuded from the skin of cattle under relatively dry conditions, and the high readings obtained after the seventh mile suggest that prolonged exercise causes 'sweating' in the Tanganyika zebu.

The work is continuing, and a more complete report will be given elsewhere. I am grateful to the Director of Veterinary Services, Tanganyika Territory, for permission to publish this communication.

R. M. Mabon

Livestock Research Section,
Veterinary Research Laboratory,
Mpwapwa,
Tanganyika Territory.
Sept. 10.

Thermionic Constants of Semi-Conductors

In some recent papers[1], we have described a convenient method of determining the thermionic constants of metals. The method consists essentially in determining, at different known temperatures, the rate of effusion of electrons through a small hole in a thin wall of a chamber made of the metal, instead of determining the direct emission from the surface. The advantage of the effusion method over the emission method is this. The expression for emission involves the transmission coefficient of the surface for electrons having the requisite momentum to cross the surface. This coefficient is very sensitive to adsorption of gases at the surface, and may differ considerably from unity. This coefficient, however, is eliminated in the expression for effusion, in the same manner in which the emissivity of the surface for electromagnetic radiations is eliminated when we take the electromagnetic radiations from a cavity through a small hole, instead of directly from the radiating surface. When the transmission coefficient is eliminated, any observed deviation of the A-coefficient in Richardson's equation from its theoretical value may be attributed to a small linear variation of the work function with temperature. Thus one is enabled by this method to determine not only the work function correctly, but also its temperature coefficient.

The thermionic constants of several metals have been determined by this method, using for this purpose a graphite chamber the walls of which were coated completely with the metal under study, by thermal or electrolytic deposition.

The main purpose of this communication is to direct attention to a new application of this method, namely, for the determination of the thermionic constants of semi-conductors, and to report some preliminary results obtained with nickel ribbons coated with the triple carbonates of barium, strontium and calcium in the molar percentages 47·5, 46·0 and 6·5 respectively. The ribbons were kindly supplied by Dr. D. A. Wright, of the Research Laboratories of the General Electric Co., Ltd., at Wembley. The ribbons were cut into pieces about 2 cm. in length, and a sheaf of them, held together at one end by a platinum foil, was fixed to the back of the graphite chamber, so that the ribbons did not come directly into contact with the graphite surface. The total surface area of these ribbons was more than twenty-five times the area of the effusion hole in our earlier measurements, and about fifty times in our later ones. The coated filaments were activated in the usual manner, and the effusion currents, corresponding to the saturation electronic vapour pressure of the oxide coat, in the temperature range 950°–1,160° K., were measured in the same manner as in our measurements on metals. (The electronic vapour pressure due to graphite, or platinum, is negligible at these temperatures.)

The currents corresponding to zero field were found to fit well with Richardson's equation, with $\varphi = 1{\cdot}55$ eV., and $A = 48$ amp. cm.$^{-2}$ deg.$^{-2}$. The latter value corresponds to a temperature coefficient of the work function $d\varphi/dT = 8 \times 10^{-5}$ eV. per deg., which is of the same order as in many metals. At 1,000° K. the current corresponding to effusion over the whole of the 2π-solid angle would be about 0·75 amp. per sq. cm. The corresponding current obtained by Elizabeth Grey[2] for maximum space-charge-limited pulsed emission directly from the surface of the oxide coat is 8 amp. per sq. cm., which is about eleven times as great. This ratio is of the order to be expected.

We thank Dr. Wright for supplying the coated ribbons, and for helpful discussions.

K. S. Krishnan
S. C. Jain

National Physical Laboratory of India,
New Delhi.
Nov. 27.

[1] Jain, S. C., and Krishnan, Sir K. S., *Proc. Roy. Soc.*, A, **213**, 143, and **215**, 481 (1952).
[2] Grey, Elizabeth, *Nature*, **167**, 522 (1951).

Use of Krypton-85 in measuring Gas Clean-up Rates

The intensity of gas discharges in switching devices for radar duplexers is such that clean-up of the rare-gas filling is an important factor, and may determine the life of such valves. Radioactive krypton, Kr-85 [1], has been used for measuring the rate of rare-gas clean-up in pre-T.R. valves, with promising results. Krypton-85 has a half-life of ten years and emits mainly beta radiation (680 keV.) and some gamma radiation (500 keV.). Thus it is a most convenient isotope to use, the radiation being readily detected by Geiger-counter or photographic techniques.

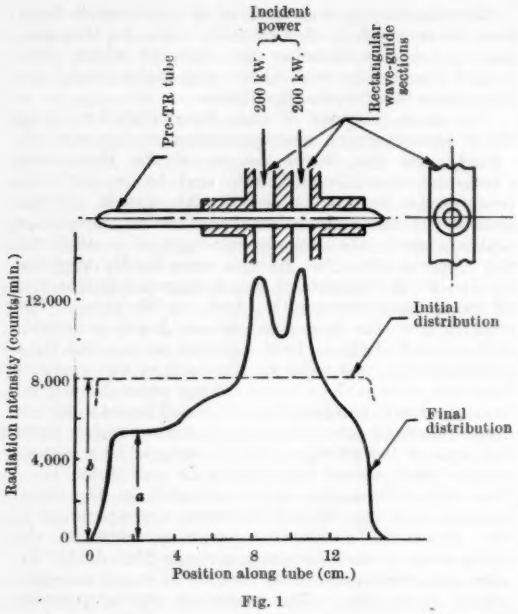


Fig. 1

Measurements using radioactive krypton can give information regarding the clean-up rate of this particular gas under certain conditions, and also enable a comparison to be made of the ability of different discharge conditions to clean-up rare gases.

Two techniques have been used to monitor the clean-up rate in pre-T.R. valves having walls of silica 0·020 in. thick: (*a*) The collimated beta radiation from a section of the valve remote from the discharge and gas clean-up region is monitored during the life of the valve, by Geiger counter. The activity then measured is due to free gas in the valve only, and hence the count-rate is proportional to the free gas density. (*b*) For low clean-up rates, a break-open test is most convenient. After a known period of life, the total activity of the valve is measured before and after breaking it open to the atmosphere. The residual activity of the valve after the free gas has escaped then corresponds to the quantity of gas cleaned-up into the walls of the valve.

A typical example of technique (*a*) is shown in Fig. 1. A silica tube pre-T.R. crosses two wave-guides, with 200 kW. of 3 cm. microwave power incident on each section of the tube. The tube contained 7 mm. mercury pressure of krypton. The lower diagram shows the distribution of the radiation emitted in a radial direction as a function of position along the tube-length, before and after a period of 250 hr. on life test. The ratio of final to initial gas pressure is given by a/b, and the area over which clean-up occurs is also indicated.

Radioactive argon and xenon are also available, but their usefulness is restricted by the low penetration from argon-37 and the short half-life (5 days) from xenon-133.

It would appear that the above techniques might be available in any experiments where clean-up of rare gases is being investigated.

The radioactive rare gases can be obtained from the Atomic Energy Research Establishment (Isotope Division), Harwell, whose helpful co-operation is acknowledged. We wish to thank the Admiralty for permission to publish this communication.

D. J. Harris
P. O. Hawkins
Services Electronics Research Laboratory,
Baldock, Herts.

[1] Radioisotope Conference, vol. 2 (1954).

Changes in Lattice Constant of Cr_2O_3 near the Curie Temperature

In 1951, a communication by me under this title was published in *Nature*[1]. It showed that as Cr_2O_3 was cooled through the antiferromagnetic transition region, the *c*-axis (hexagonal setting) contracted sharply, whereas the *a* axes decreased almost linearly. Recently, R. J. Davis and W. E. Armstrong (private communication), in a study of a system involving Cr_2O_3, found that the lattice parameters at room temperature of their Cr_2O_3 sample did not agree with those given by me. They also suggested that the cause of the disagreement was my indexing the $42\bar{2}$, 664 rhombohedral reflexion pair as the $42\bar{2}$, 652 pair. Re-examination of the data and a few additional measurements have shown that this is indeed the case.

Davis and Armstrong's values at 23° C. are plotted on Fig. 1 for comparison with the values obtained by re-indexing my results. It is apparent that a slight discrepancy in the *c*-values still exists. Fig. 1 also shows that the *c*-axis lengthens rather than contracts as the material is cooled through the antiferromagnetic transition region, whereas the *a*-axes decrease in a non-linear fashion in the same temperature-range.

The c/a ratio for Cr_2O_3 is observed to increase as the temperature is lowered through the transition. The rhombohedral angle α decreases sharply in the transition region, and the rhombohedral *a*-axes decrease linearly within the experimental error.

New observations have been made at room temperature and at approximately 95° K. with a 'Norelco' high-angle goniometer diffractometer. In the front reflexion region, there is no ambiguity in indexing, and the changes in position of the 110 and

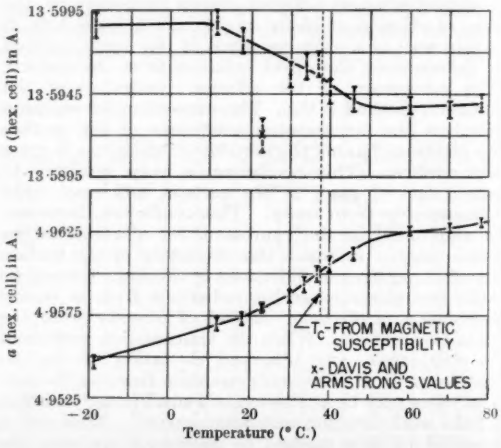


Fig. 1. Lattice parameters (hexagonal setting) of Cr_2O_3 as a function of temperature

104 reflexions should be sensitive to changes in the c/a ratio, since one reflexion depends on the values of the a-axes and the other mainly on the value of the c-parameter. These measurements show that the c/a ratio is larger at 95° K. than at room temperature.

As a more quantitative check, the curves shown in Fig. 1 were extrapolated to 95° K. The values so obtained for a and c, 4·944 A. and 13·599 A., respectively, agree very well with the results for the 226 and 21·10 reflexions from the diffractometer measurements at that temperature.

I thank Dr. Donald A. Edwards for making the low-temperature measurements, and Dr. J. Samuel Smart for helpful discussions.

SELMA GREENWALD
U.S. Naval Ordnance Laboratory,
White Oak, Maryland.

[1] Greenwald, S., *Nature*, **168**, 379 (1951).

Colour Centres in Metaphosphate Glass

IN a recent communication[1], Basu states that we have attributed the coloration of metaphosphate glasses, induced by X-rays, to the activating influence of the metal (aluminium, barium, silver, etc.) in the glass, and that his results with sodium metaphosphate glasses show that 'F-centres' can be produced without these activators. In the references to our work cited by Basu[2,3], the point is made that radiophotoluminescent centres having certain specific properties are connected with the presence of silver in potassium–barium–aluminium metaphosphate glass. It is clearly shown, we believe, in the publications from this Laboratory[3–5] that a visible coloration is produced upon X-irradiation of the above silver-free base glass, two broad bands appearing with peaks at about 420 mμ and 530 mμ. These colour centres were not attributed to any 'activating' influence of the aluminium, barium or other metallic constituents of the glass.

JAMES H. SCHULMAN
Solid State Division,
U.S. Naval Research Laboratory,
Washington 25, D.C.

[1] Basu, *Nature*, **176**, 265 (1955).
[2] Schulman *et al.*, *J. App. Phys.*, **22**, 1479 (1951).
[3] Schulman, *NRL* Memo Report 266 (1954).
[4] Schulman, *J. Phys. Chem.*, **57**, 749 (1953).
[5] Schulman *et al.*, *Nucleonics*, **13**, 30 (1955).

WHEN writing my communication published in *Nature* of August 5, I had to rely on abstracts of Mr. Schulman's papers; this was responsible for my misrepresentation of Mr. Schulman's point of view. The information now supplied by Mr. Schulman is very interesting, for it appears that none of the bands observed in my system is present in the silver-free base studied by Schulman, and his 420-mμ band is completely absent in my system. This shows that a more critical study of this system is necessary before these bands can be assigned definitely to various trapping centres, although I have made some tentative assignment from the study of glass systems of different composition.

SADHAN BASU
Department of Chemistry,
University of Calcutta,
92 Upper Circular Road,
Calcutta 9.

Reproduction of Potato Root Eelworm during the Winter in a Potato Clamp

IN early March 1955, a freshly opened clamp of King Edward potatoes was inspected at Little Downham, Isle of Ely. It was observed that cysts of potato root eelworm (*Heterodera rostochiensis*) had already formed on the roots of many tubers which had sprouted and grown in the clamp. The cysts were in various stages of development. Some were white and others had turned yellow and contained fully embryonated eggs. It was estimated that there were more than a hundred cysts on some root systems. The wet autumn of 1954 had made lifting conditions very difficult and much damp soil had been clamped with the potatoes. Under these conditions root growth had been induced, and it is certain that the larvæ must have invaded the roots within the clamp and completed their development during the winter.

The field, on the black fen, was sampled to determine the level of infestation. The infestation was severe—5·24 viable cysts per gm. and 1,072 eggs per gm. of air-dried soil.

When a field is lightly infested with potato root eelworm, the clamp site will quickly become contaminated, as some soil will be deposited there from all parts of the field during harvesting operations. In addition, a clamp site often supports a high population of volunteer potatoes which will help to build up the eelworm numbers. If reproduction occurs within the clamp, the level of infestation may be increased still further, even though it is possible that many larvæ do not reach maturity under these conditions.

T. J. LEGOWSKI
E. B. BROWN
National Agricultural Advisory Service,
Anstey Hall,
Trumpington,
Cambridge.
Oct. 3.

Migration of Nematodes

THE relationship between hydrostatic pressure-deficiency and the migration of larvæ of the beet eelworm, *Heterodera schachtii* Schmidt, has been described previously[1]. It was shown that larval mobility was low in sand in which water was confined to the points of contact of sand particles. It was suggested that more critical experiments would be needed to determine whether there was an optimum pressure-deficiency for eelworm migration.

Accordingly, an apparatus (Fig. 1) was devised for examining this problem further, using the stem eelworm *Ditylenchus dipsaci*. *a–b* is polythene tubing,

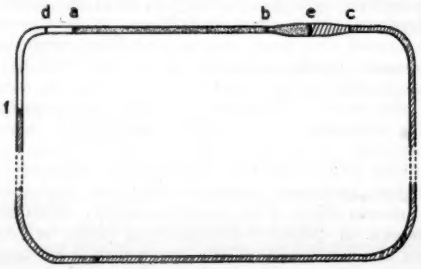


Fig. 1

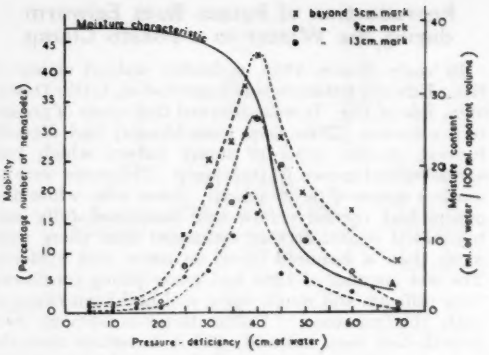

Moisture characteristic
x beyond 5cm. mark
o " 9cm. mark
• " 13cm. mark
Mobility (Percentage number of nematodes)
Moisture content (ml. of water / 100 ml. apparent volume)
Pressure - deficiency (cm. of water)

Fig. 2

18 cm. long and of 0·5-cm. bore; *b*–*c* is a glass tube containing a sintered-glass plate *e*; *c*–*d* is a loop of polythene tubing of the same bore as *a*–*b*, and *d*–*a* is a glass connecting tube. Sand of particle-size 200–400μ extends from *a* to *e*, and water extends from *e* to *f*. By varying the distance of the water meniscus *f* below the tube *a*–*b*, the hydrostatic pressure-deficiency in the sand can be regulated. A series of tubes was set up in this manner giving a range of pressure-deficiencies. About 10,000 eelworms in a drop of water were introduced into the sand at *a*. Previous experiments showed that the eelworms were carried from the end of the tube as the drop of water became distributed in the sand. However, no eelworms were carried more than 1 cm. in this way. After 16 hr., each polythene tube was cut into 1-cm. lengths and the number of eelworms in each section counted. The distribution of eelworms along each tube was thus obtained.

The results (Fig. 2) have been expressed graphically to show the percentage number of eelworms which were recovered beyond the 5, 9 and 13 cm. marks from the inoculation site (*a*, Fig. 1), at each pressure-deficiency. The moisture characteristic of the sand is also shown. As pressure-deficiency increases from 5 to 40 cm. of water, there is a corresponding rise in migration of eelworms. For pressure-deficiencies greater than 40 cm. of water, there is a decline in migration. The pressure-deficiency for maximum mobility of *D. dipsaci* in sand of particle size 200–400μ is thus 40 cm. of water, the point at which about 25 per cent of the pore space is occupied by air.

Observations suggest that *D. dipsaci* moves farther in a thin water film than when it is in a thick layer of water. Further investigation of this problem is needed; but if this statement is accepted as a hypothesis, then it is possible to account for the relationship between eelworm mobility in sand and deficiency of hydrostatic pressure as follows. At low pressure-deficiencies the pore spaces are filled with water, air–water interfaces will be absent and mobility will consequently be low. Under these conditions, aeration will also be at a minimum and this may also inhibit active migration. As pressure-deficiency increases, air appears in the pore spaces, and movement in the resulting water films is consequently increased. In addition, increased aeration may also contribute to the general effect of increased mobility. With further increases in pressure-deficiency a point is reached when the continuity of the water film is broken. At this stage (point *A* on the moisture characteristic, Fig. 2), the nematodes are probably confined to water at the points of contact of sand particles. Progression through the sand will then entail a bridging of the air gap between water droplets, and this would inhibit migration in spite of high aeration.

Experiments with *Heterodera schachtii* indicate that there is a similar relationship between the distribution of water in sand and migration. Work is at present in progress on the factors influencing the migration of this species in soil.

I am indebted to the Sugar Beet Research and Education Committee for providing facilities for carrying out this work.

H. R. Wallace*

School of Agriculture,
University of Cambridge. Oct. 6.

* Present address: Rothamsted Experimental Station, Harpenden, Herts.

[1] Wallace, H. R., *Ann. App. Biol.*, **43**, 477 (1955).

Prevention of Toxæmia of Late Pregnancy in Sheep

Disability and death in ewes during late pregnancy and the puerperium due to toxæmia of pregnancy (twin-lamb disease) are an important cause of loss to the sheep industry in most of the principal sheep-raising countries of the world[1].

Although many observers have stressed the importance of a change in the nutrition of polytocous ewes during late pregnancy in the etiology of the disease[2], my recent observations in Britain suggested that excessive gain of weight in early pregnancy might render ewes particularly prone to develop toxæmia if they were subjected to changes in nutrition or other stresses in late pregnancy[3]. This hypothesis has been used empirically as the basis for a system of antenatal care designed to control the occurrence of the disease, which is meeting with considerable success. As the annual loss from the disease has been estimated to be £1–£2 million in Britain and £10 million in the Commonwealth[4], it seemed desirable to make some preliminary results available now.

The relevant details of consecutive lambings in some fifty lowland flocks in England and Scotland are set out in Table 1. The striking reduction in the number of cases of toxæmia and in the number of deaths in groups 1 and 2 is immediately apparent. The results in group 3 in 1955 would have been much better but for one large flock which had a mortality-rate of 12·6 per cent caused by failure to follow instructions and make adequate adjustments in the feeding during a spell of severe weather. If this flock is excluded, the figures, shown in brackets in the table, are excellent. These results are most encouraging, particularly in view of the maintenance of the average litter-size and indeed its increase in 1955 in two of the three groups to more than 1½ lambs per ewe. As it has proved impracticable to obtain results from unsupervised flocks which might serve as a control, this study should obviously be continued for a longer period to take into account the well-known natural fluctuations in the occurrence of the disease from year to year; but the fact that such a low rate of attack was attained in 1955 when the disease in many neighbouring flocks was more prevalent than usual (Parker, W. H., personal communication) suggests that the general hypothesis may be substantially correct.

Table 1. DATA RELATING TO THE OCCURRENCE OF TOXÆMIA OF LATE PREGNANCY IN CERTAIN BRITISH LOWLAND SHEEP FLOCKS, 1953–55

Group	Year of supervision		No. of flocks	No. of ewes at risk*	Average litter size†	Pregnancy toxæmia			Attack-rate per 1,000 ewes at risk*	
						Total cases	Died	No. of flocks affected	Morbidity	Mortality
1 (Pedigree Suffolk folded flocks in England and Scotland)	1st	1953	28	4,138	1·39	66	62	7	16·0	15·0
	2nd	1954	27	4,055	1·29	31	13	8	7·6	3·2
	3rd	1955	31	4,463	1·54	13	11	9	3·0	2·5
2 (Commercial flocks on grass in North-West England)	1st	1953	21	1,909	1·60	41	27	9	21·5	14·3
	2nd	1954	24	2,171	1·48	8	6	4	3·7	2·8
	3rd	1955	20	2,023	1·36	3	3	1	1·7	1·7
3 (Commercial flocks folded and on grass in Southern England)	1st	1954	5	1,987	1·45	46	42	4	32·5	30·0
	2nd	1955	5	2,211	1·63	61	54	5	27·6	24·4
			4‡	1,781	1·62	7	3	4	3·9	1·7

* Ewes at risk is the number of ewes put to ram less those barren, those aborting (before 135 days of gestation) and those lost by accident and death, excepting those dying of pregnancy toxæmia.
† Average litter size is the ratio of the total number of lambs carried by the ewes at risk, that is, the total number of live and dead born lambs plus the lambs carried by ewes dying of pregnancy toxæmia, divided by the number of ewes at risk.
‡ Excluding one flock (see text).

The system of ante-natal care, which has been used with individual modifications in all the flocks, has aimed at restricting the gain of weight of the ewes during early pregnancy, while ensuring good gains during late pregnancy. As soon as the ewes are known to be pregnant, their nutriture has been maintained unchanged as far as possible by control of the food intake, either by varying the size of the fold or the amount of grazing allowed. About six to eight weeks before lambing is due (depending on the weather), the food intake has been increased, either by allowing access to improved grazing or more usually by feeding supplements of corn, hay, etc. A common method has been to give a concentrate feed containing about 10 per cent of good-quality protein, commencing with ¼ lb. a head a day and increasing to 2 lb. a day for the last fortnight before parturition; during periods of severe weather, these amounts may be increased. At the same time, provision has been made for plenty of exercise, and any cases of the common ailments such as contagious foot-rot treated at once. Further details of these measures have been given elsewhere[5].

H. B. PARRY

Nuffield Institute for Medical Research,
Woodstock Road,
Oxford.
Aug. 18.

[1] Groenewald, J. W., Graf, H., and Clark, L., *Onderstep. J. Vet. Sci.*, 1941, **17**, 225 and 241 (1944).
[2] Franklin, M. C., Johnstone, I. L., and Parry, H. B. (1942); see Parry, H. B., "Toxæmias of Pregnancy: Human and Veterinary", 85. A Ciba Foundation Symposium, edit. by J. Hammond, F. J. Browne and G. E. W. Wolstenholme (Churchill, London, 1950).
[3] Parry, H. B., *J. Physiol.*, **126**, 40*P* (1954).
[4] Parry, H. B., *Proc. Brit. Soc. Anim. Prod.* (in the press).
[5] Parry, H. B., *Suffolk Sheep Soc. Yrbk.*, 26 (1953).

A Bathynellid from the New World

THE species of the syncarid family Bathynellidae are typical representatives of the subterranean freshwater fauna. There are three known genera, *Bathynella* from Europe, *Parabathynella* from Europe, Madagascar, Malaya and Japan, and *Thermobathynella* with the species *adami* Capart from the Belgian Congo and *leleupi* Debouttéville and Chappuis from Lake Tanganyika[1,2].

A locality on the American continent can now be added. In 1954 S. Gerlach undertook a voyage to Brazil, assisted by a fellowship of São Paulo University and the Deutsche Forschungsgemeinschaft. On January 13, 1955, he discovered a bathynellid species at Icoaraci, about 17 km. north of Belém (Parà), by the bank of the River Parà about 80 km. upstream from the ocean. The beach of Icoaraci consists of pebbles, gravel and clay. A little pit had been dug at a distance of about 1 m. from the shore. The subsoil water appeared 10–15 cm. below the beach surface. The water did not smell brackish, but Dr. H. Sioli states that at least in the dry season of the year the water at Icoaraci and up to Belém used to be brackish.

The sample contained three specimens of Bathynellids, some oligochaetes, polychaetes and acari, one harpacticoid copepod and numerous nematodes. Most of the nematodes belong to the species *Onchulus longicaudatus* Cobb. This species has been described "from soil about the roots of living plants imported from Brazil into the United States"[3], so the actual habitat of the type specimen is unknown. But it is an interesting fact that *Onchulus nolli* Goffart, the only other representative of the genus, may be considered a truly stygobiont European species, found exclusively in subsoil freshwater biotops and sometimes even together with *Bathynella natans* Vejdovsky[4].

The new bathynellid species from Brazil is a representative of the genus *Thermobathynella* Capart, the second antenna consisting of five joints and extremities lacking on the eighth thoracic segment. It can be distinguished from *Th. adami*[4] and from *Th. leleupi*[2] by the first antenna, which consists of five joints instead of six, and by the fact that epipodites are lacking on the first two pairs of thoracopods. In the arrangement of the setæ on uropods and furca the new species is similar to *Th. leleupi*.

A comprehensive description will be published in *Kieler Meeresforschungen*.

SEBASTIAN A. GERLACH
ROLF SIEWING

Zoological Institute,
University of Kiel.

[1] Delamare Debouttéville, C. Y., and Chappuis, P.-A., *Arch. Zool. Exp. et Gén.*, **91** (1954).
[2] Delamare Debouttéville, C. Y., and Chappuis, P.-A., *Notes biospéolog.*, **10** (1955).
[3] Cobb, N. A., *Contrib. Sci. Nematology*, **9** (1920).
[4] Noll, W., and Stammer, H. J., *Mitteilg. Naturwiss. Museum Aschaffenburg, N.F.*, **6** (1953).
[5] Capart, A., *Bull. Inst. Roy. Sci. Nat. Belgique*, **27** (1951).

Corrosion and Shell Composition in Barnacles

It was originally suggested by Darwin[1] that the susceptibility to disintegration of the shell of the common littoral barnacle, *Chthamalus stellatus* (Poli), was a consequence of its high content of organic matter. This suggestion has been accepted by many authors; but there appears to be no analysis to support the contention.

The organic matter and calcium content of the shells of several common barnacles, namely, *C. stellatus*, *Balanus balanoides* (L.), *B. crenatus* Brug. and *B. balanus* (L.) Da Costa, have been determined. In each case, fifty well-formed individuals of about 10 mm. rostro-carinal diameter were used. *Chthamalus stellatus* was taken from the upper level of the shore, *Balanus balanoides* and *B. crenatus* from mussel shells near low-tide level and *B. balanus* from material dredged at 20 m. The soft parts were removed, and the shells thoroughly cleaned by brushing; in the case of *Chthamalus stellatus* it was not possible to remove all the adherent unicellular green algae. The shells were then dried at 105° C., the inorganic material dissolved in dilute hydrochloric acid and the residual organic matter separated, washed and dried. Calcium was determined in the solution by a double precipitation as oxalate followed by titration with standard potassium permanganate solution. The results are shown in Table 1.

Table 1
(All values as percentage oven dry material)

Species	% Organic fraction	% Calcium as $CaCO_3$ of inorganic fraction
C. stellatus	2·1	91·1
B. balanoides	1·1	91·8
B. crenatus	0·6	90·7
B. balanus	0·8	93·4

It is evident that while the calcium content remains very uniform, *C. stellatus* contains a relatively larger organic content. However, when the difficulty of removing the unicellular green algae from this species is remembered it may be doubted whether the larger organic content at such a low value of the total is, *per se*, responsible for the increased susceptibility to corrosion. It is suggested that this is rather a function of the structure of the compartments than the quantity of organic material. Although the walls of *C. stellatus* have no parietal tubes they are permeated by numerous fine tubules. The latter are also present in the compartments of *Balanus balanus* (which undergoes corrosion) together with a number of small irregular pores. The presence of these tubules near the surface of the outer lamella could weaken the wall and allow corrosion to take place. In less-corrodible species quite large parietal tubes may be present, but these are flanked by solid calcareous wall. In support of this suggestion, it may be pointed out that in some species of *Tetraclita* notable for their extreme corrosion, although tubules are absent, the walls are permeated by several rows of thin-walled parietal tubes so that in section the compartments have a honeycomb appearance; the solid character of the wall and its resistance to corrosion are thereby destroyed.

H. Barnes

The Marine Station,
Millport, Scotland.
Oct. 8.

[1] Darwin, C. R., "A Monograph of the Sub-Class Cirripedia" (Ray Society, London, 1854).

Dimorphism in the Portuguese Man-of-War

The Portuguese man-of-war (*Physalia*) occurs in two forms which are mirror images of one another but otherwise identical. Under the influence of the wind, one form (left-handed) moves to the right of the downward direction, the other (right-handed) to the left.

Woodcock[1] was the first to attempt to relate these facts to wind and water movements. He observed that a large majority of specimens from the North Atlantic and Gulf of Mexico were right-handed, and sailed to the left of the downwind direction. To explain this, Woodcock formed a hypothesis which required in part that southern hemisphere forms be mirror images of northern hemisphere forms, and sail to the right of the downwind direction. An examination of museum specimens seemed to show that there was, in fact, a preponderance of right-handers from the southern hemisphere (19 out of 22). Fontaine[2] observed, however, that the forms driven ashore on the southern coast of Jamaica were always left-handers. The prevailing wind was from the east.

In the Canary Islands this year we observed that forms driven into the harbour at Arrecife, which lies on the eastern coast of Lanzarote, were always left-handers when the wind came from the east or north-east. On one occasion when the wind came from the south-west, right-handers were driven in.

It seems probable from Fontaine's and our own observations that the proportion in which the two forms are found varies in particular localities not according to the hemisphere but according to the position of adjacent land and the direction of the wind.

We tentatively put forward the view that in each brood of *Physalia* the two forms are produced in rough equality, and that this has survival value in that it obviates the stranding of the whole brood in any one set of circumstances. The early development of *Physalia* is little known so it is impossible to say whether or not the two forms are genetically different.

Crude experiments were made by one of us to ascertain the speed and angle of drift of *Physalia*. In light-to-moderate breezes the following results were obtained with the aid of a spherical glass float, a chart and landmarks inside the mole at Arrecife. Towards the end of flood-tide on April 15 the speed of drift over the tide was 20 m./min. On April 16 at slack-water the courses taken by a number of animals moving across the wind varied from 34° to 42° to the right of the downwind direction. A boat sailing into the wind makes more forward than lateral way, but *Physalia*, though pointing up to the wind, makes much lateral and slight stern way.

A. K. Totton

British Museum (Natural History),
Cromwell Road,
London, S.W.7.

G. O. Mackie

Dept. of Zoology and Comparative Anatomy,
University Museum,
Oxford.
Sept. 28.

[1] Woodcock, A. H., *J. Mar. Res.*, **5**, 196 (1944).
[2] Fontaine, A., *Notes Nat. Hist. Soc. Jamaica*, **64**, 61 (1954).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 13

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Lord Halsbury: "The Semantics of Determinism".

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "Power Supplies to Electrical Laboratories". Opening Speaker: Dr. P. F. Soper.

Tuesday, February 14

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. R. T. Green: "Psychology and the Search for a Model".*

ZOOLOGICAL SOCIETY OF LONDON (in the Mappin Refreshment Pavilion, Mappin Terrace, Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—H.E. Mrs. Vijaya Lakshmi Pandit, High Commissioner for India in London: "The New India" (Sir George Birdwood Memorial Lecture).

IMPERIAL COLLEGE (in the Main Chemistry Lecture Theatre, Imperial Institute Road, London, S.W.7), at 5.30 p.m.—Prof. D. G. Christopherson: "Reflections on the Education of Engineers in a University" (Inaugural Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENT AND CONTROL SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. J. F. Coales and Mr. A. R. M. Noton: "An On–Off Servomechanism with Predicted Change-Over".

ROYAL SOCIETY OF MEDICINE, EXPERIMENTAL MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 5.30 p.m.—Discussion on "Clinical and Experimental Studies with Radioactive Iron". Opening Speakers: Dr. L. F. Lamerton, Dr. Mary Smith and Dr. M. S. R. Hutt.

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. F. B. Shepherd: "Manufacture of Phosphorus".

SOCIETY FOR ANALYTICAL CHEMISTRY, PHYSICAL METHODS GROUP (in the meeting room of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Meeting on "Polarography".

Wednesday, February 15

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. L. H. Bedford: "The Arithmetic of the Musical Scale".

EUGENICS SOCIETY (at Manson House, 26 Portland Place, London, W.1), at 5 p.m.—Mr. Frederick Osborn: "Galton and Mid-Century Eugenics" (The Galton Lecture).*

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. D. H. Sadler: "The Abridged Nautical Almanac"; Mr. P. Beeham: "Navigating Without Instruments"; Dr. J. G. Porter: "The Earth Satellite Project".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Discussion meeting on "Measurement of Water Vapour in the Stratosphere".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. P. E. Hart and Dr. S. J. Prais: "The Analysis of Business Concentration—a Statistical Approach".

INSTITUTE OF FUEL (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Prof. J. Ivon Graham (Dunedin): "Fuel Conditions in New Zealand with special reference to the Coal Industry".*

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. D. Lacy: "Cell Inclusions in Vertebrate and Invertebrate Cells by Light and Electron Microscopy".

ASLIB (at the Royal Society of Arts, 8 John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Dr. D. McKie: "Sources of Information in the History of Science".

INSTITUTION OF ELECTRICAL ENGINEERS (at the Central Hall, Westminster, London, S.W.1), at 6 p.m.—Mr. B. L. Metcalf: "Coal Mining Electrically" (Faraday Lecture).

BRITISH PSYCHOLOGICAL SOCIETY (joint meeting of the EDUCATION and INDUSTRIAL SECTIONS, in Room 173/4, Institute of Education, Malet Street, London, W.C.1), at 6.30 p.m.—Prof. L. J. Cronbach: "Technical Recommendations of the United States Committee on Test Standards".

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (at the Institute of Metals, 4 Grosvenor Gardens, London, S.W.1), at 6.30 p.m.—Dr. B. C. Saunders: "Some Properties and Reactions of the Enzyme Peroxidase".

Thursday, February 16

PHYSICAL SOCIETY, LOW TEMPERATURE GROUP (at the Royal School of Mines, London, S.W.7), at 4 p.m.—Dr. H. Ziebland: "Transport Properties of Liquefied Gases".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. W. A. Sledge: "Observations on the Fern Flora of Ceylon"; Dr. P. Van Royen: "The Netherlands Botanical Expedition 1954–55 in New Guinea".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. A. H. Cook, Mr. H. Meyer and Mr. W. P. Wolf: "A New Method of Correlating the Magnetic Temperature Scales of Paramagnetic Salts below 1° K."; Mr. C. D. Clark, Mr. R. W. Ditchburn and Mr. H. B. Dyer: "The Absorption Spectra of Natural and Irradiated Diamonds".

INSTITUTION OF MINING AND METALLURGY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. P. F. Whelan and Dr. D. J. Brown: "Particle-bubble Attachment in Froth Flotation"; Mr. F. A. Williams: "The Identification and Valuation of Decomposed Columbite-bearing Granites of the Jos-Bukuru Younger Granite Complex, Nigeria".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. G. W. Whitehead: "Suspension Theorems".

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. L. J. Kastner: "Some Engineering Problems" (Inaugural Lecture).*

INSTITUTION OF MECHANICAL ENGINEERS, EDUCATION GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "Technical Authorship and Illustration".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Discussion on "Sickkæmia". Opening Speaker: Dr. A. C. Allison.

Friday, February 17

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Scientific Papers.

Saturday, February 18

BIOCHEMICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Symposium on "The Structure of Nucleic Acids and their Role in Protein Synthesis".

BRITISH PSYCHOLOGICAL SOCIETY (in the Gustave Tuck Theatre, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Dr. M. L. Johnson: "Exploring in Group Discussions the Factors Affecting Scientific Judgment".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

BIOCHEMIST, Basic grade (with a B.Sc. degree with honours in biochemistry or chemistry or equivalent qualification)—The House Governor, The General Hospital, Birmingham 4 (February 18).

LECTURERS (2) IN STATISTICS—The Secretary, The University, Aberdeen (February 18).

ENTOMOLOGIST (under 30, with a degree with entomology as a special subject) in the Department of Research and Specialist Services, Ministry of Agriculture, Federation of Rhodesia and Nyasaland, for duties which will include laboratory and field research on insects and their near relatives, extension and advisory work mainly on agricultural entomology, but including some medical and veterinary entomology—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (February 24).

ASSISTANT ASTRONOMER in the Government Observatory, Perth, Western Australia, for duties mainly relating to research work in positional astronomy and photographic astronomy—Public Service Commissioner, 60 Barrack Street, Perth, Western Australia (February 29).

ORGANIC CHEMIST (Scientific Officer grade) at the Long Ashton Research Station—The Registrar and Secretary, The University, Bristol 8 (February 29).

ASSISTANT AGRICULTURAL ECONOMIST (graduate in economics and/or agriculture–horticulture) at Newton Abbot—The Registrar, The University, Bristol (March 1).

ASSISTANT EXPERIMENTAL OFFICER (preferably with a degree in botany or agricultural botany) for work on cereal diseases—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (March 1).

ASSISTANT LECTURER or DEMONSTRATOR IN PATHOLOGY, and an ASSISTANT LECTURER (with special qualifications in applied mathematics) IN MATHEMATICS—The Registrar, The University, Manchester 13 (March 3).

ASSISTANT LECTURERS (2) IN ZOOLOGY—The Secretary, Birkbeck College (University of London), Malet Street, London, W.C.1 (March 3).

DEPUTY LIBRARIAN—The Registrar, The University, Sheffield (March 3).

MORPHOLOGIST (with a university honours degree in botany and research experience) IN THE DIVISION OF FOREST PRODUCTS, Section of Wood and Fibre Structure, Commonwealth Scientific and Industrial Research Organization, South Melbourne, Victoria, Australia, to carry out investigations on cell differentiation and fibre structure with special reference to lignification—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 290/437 (March 3).

RESEARCH OFFICER (with a university honours degree in science or agricultural science, and preferably with postgraduate research experience) IN THE DIVISION OF SOILS, Commonwealth Scientific and Industrial Research Organization, Australia, to undertake surveys and field pedological studies of Australian soils—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (March 3).

LECTURER IN PHYSICS—The Registrar, King's College, Strand, London, W.C.2 (March 9).

LECTURER (with a research degree in nutrition, biochemistry or chemistry, followed by specialization in nutrition or biochemistry) IN BIOCHEMISTRY AND NUTRITION at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, March 15).

TUTOR (with a good honours degree in natural or physical sciences, and preferably with experience in extra-mural work) IN SCIENCE—The Director of Extra-Mural Studies (University of Glasgow), 91 Oakfield Avenue, Glasgow, W.2 (March 15).

CHAIR OF NUCLEAR POWER, and READER IN NUCLEAR POWER, at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 16).

LECTURER (with an honours degree in geography and special qualifications in physical and economic geography and geomorphology) IN GEOGRAPHY in St. Salvator's College—Joint Clerk to the University Court, The University, St. Andrews (March 17).

CHAIR OF GEOLOGY—The Registrar, University College, Singleton Park, Swansea (March 20).

IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOWS IN BIOCHEMISTRY, CHEMISTRY, CHEMOTHERAPY, ENGINEERING, METALLURGY, PHARMACOLOGY, PHYSICS and subjects allied to chemistry or physics—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

DEMONSTRATORS IN PHYSICS, and DEMONSTRATORS IN ORGANIC CHEMISTRY—The Registrar, The University, Nottingham.

DEPUTY DIRECTOR (with a good scientific background and able to formulate research projects which meet from time to time the needs of the industry, and also able to lead a research group successfully)—The Secretary, British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester 22.

LECTURER (with high academic qualifications and some experience in the practical applications of electronics) IN ELECTRONIC ENGINEERING, with particular reference to electronics for purposes other than communications—The Registrar, The University, Bristol.

MASTER TO TEACH MATHEMATICS up to advanced level standard—The Director of Studies, Nautical College, Pangbourne, Berkshire.

MICROBIOLOGIST (with a first- or second-class honours degree or equivalent qualification, and preferably with research experience), to assist in the study of fungi, moulds, etc., in their research aspects and in respect to their part in producing deterioration of materials, especially woods and textiles, under a variety of tropical environments (Ref. G.34/6A/AA); and CHEMISTS (with a first- or second-class honours degree or equivalent qualification, and preferably with research experience) for work on general chemical problems (with opportunities for research) associated with the scientific study of the behaviour of a wide variety of materials (plastics, rubber, metals, fibres, etc.) in tropical environments (Ref. F51/6A/AA), at the Tropical Testing Establishment, Port Harcourt, Nigeria—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No.

PHYSICAL CHEMISTS or PHYSICISTS (with a first- or second-class honours degree or equivalent in chemistry or physics and an interest in the study of high-speed phenomena) at a Ministry of Supply Research and Development Establishment, Waltham Abbey, Essex, to study detonation and deflagration phenomena in explosive systems—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.35/6A/AA.

PHYSICIST or ENGINEER (with a first- or second-class honours degree or equivalent and preferably with experience of servomechanisms, analogue computers or applied electronics) at the Royal Aircraft Establishment, Farnborough, Hants, for work on instruments for flight control and navigation—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.13/6A/AA.

PHYSICIST (with a first- or second-class honours degree or equivalent in physics, and preferably with experience in one or more of the following: transducers, electrical recording apparatus, permanent magnetism and pyrometry) at a Ministry of Supply Research and Development Establishment, Waltham Abbey, Essex, for experimental investigations including study of transient mechanical phenomena—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.29/6A/AA.

PHYSICISTS and ELECTRICAL ENGINEERS, Scientific Officer or Senior Scientific Officer grade (with a first- or second-class honours degree in physics or electrical engineering), at the Ministry of Supply Fighting Vehicles Research and Development Establishment, near Chertsey, Surrey, to study problems of crossing rough and soft ground by tracked and wheeled vehicles and to develop electronic recording techniques for evaluation of soil stresses and associated automotive problems—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.489/5A/AA.

PHYSIOLOGIST (with a good honours degree in botany, and some postgraduate experience in plant physiology), at the Cotton Research Station, Namulonge, Uganda, to study the growth of the cotton plant with particular reference to the physiology of crop development and lint quality—The Secretary, Empire Cotton Growing Corporation, 12 Chantrey House, Eccleston Street, London, S.W.1.

PRINCIPAL (under 45, with a university degree in forestry, mature experience and an aptitude for instructing in all spheres of forestry subjects) OF THE FOREST TRAINING SCHOOL, Londiani, Kenya—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, Westminster, London, S.W.1, quoting BCD.61/7/06.

RESEARCH ASSISTANT (Biochemist or Biologist) to work on problems of nutrition and fertility, involving chiefly experiments with laboratory animals—The Secretary, Queen Elizabeth College (University of London), Campden Hill Road, London, W.8.

RESEARCH PHYSICISTS; ELECTRICAL, ELECTRONIC and MECHANICAL ENGINEERS, with the European Organization for Nuclear Research, Geneva, to assist in the design and construction of high energy accelerating machines and to carry out nuclear research—The Ministry of Labour and National Service, Almack House, 26 King Street, London, S.W.1, quoting A.12/SW.1/18/CERN.

THEORETICAL NUCLEAR PHYSICIST (with a first-class honours degree in mathematics or physics, together with several years postgraduate research experience in nuclear physics), to carry out fundamental research in nuclear physics, particularly on the theory of nuclear structure—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting Ref. No. A.799/2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Objects and Method in Geographical Studies. (An inaugural lecture delivered at University College, Leicester, 2 June, 1955.) By Prof. Norman Pye. Pp. 1+19. (Leicester: University College of Leicester, 1955.) 1s. [612

Ministry of Agriculture, Fisheries and Food. Bulletin No. 165: Weather and the Land. Prepared by the Agricultural Branch of the Meteorological Office (Air Ministry). Pp. iv+35+4 plates. (London: H.M. Stationery Office, 1955.) 3s. net. [612

Coal Tar Research Association. Review of Coal Tar Technology. January–June, 1955. (Vol. 7, Part 1.) Pp. 91. (Gomersal, Nr. Leeds: Coal Tar Research Association, 1955.) 7s. 6d. [612

The Projection of England. By Sir Stephen Tallents. (Originally published in 1932.) Pp. 46. (London: Olen Press, 1955. Published for Film Centre Limited.) 5s. [612

Laboratory Animals Bureau. Collected Papers, 1955. Vol. 3: The Breeding of Laboratory Animals. Pp. 92. (London: Laboratory Animals Bureau, 1955.) 7s. 6d. [612

Titration in Non-Aqueous Solvents. By A. H. Beckett and E. H. Tinley. Pp. ii+35. (Poole: British Drug Houses, Ltd., 1955.) [612

British Drug Houses, Ltd. Technical Information: 4-Dimethylaminobenzaldehyde. Pp. 21. (Poole: British Drug Houses, Ltd., 1955.) [612

Imperial College of Science and Technology (University of London). Report on Research Work in the City and Guilds College 1952–55. Pp. ii+61. (London: Imperial College of Science and Technology, 1955.) [612

Other Countries

Institut Royal Météorologique de Belgique. Contributions. No. 22: Éléments de Météorologie. Chapitre 2: Mesures en Altitude. Par L. Malet. Pp. 49–80. Publications, Série B. No. 18: La mesure de la conductibilité par radiosonde. Par Dr. L. Koenigsfeld. Pp. 8. (Uccle, Bruxelles: Institut Royal Météorologique de Belgique, 1955.) [612

Metropolitan Life Insurance Company. Statistical Bulletin. Vol. 36, No. 10: The American Wife. Pp. 12. (New York: Metropolitan Life Insurance Company, 1955.) [612

United States Department of Agriculture. Technical Bulletin No. 1118: The Biology and Ecology of the Red-Headed Pine Sawfly. By Daniel M. Benjamin. Pp. 57. (Washington, D.C.: Government Printing Office, 1955.) 20 cents. [612

Agricultura Tecnica en Mexico. Ano 1, No. 1 (Julio, 1955). Pp. 40. (Mexico, D.F.: Agricultura Tecnica en Mexico, 1955.) [612

Wattle Research Institute (South African Wattle Growers' Union—University of Natal—Union Department of Forestry). Report for 1954–1955 (Eighth Year). Pp. 37. (Pietermaritzburg: Wattle Research Institute, University of Natal, 1955.) [612

Institut des Parcs Nationaux du Congo Belge. Exploration du Parc National Albert. Mission d'Études Vulcanologiques. Fascicule 1: Aperçu Historique de l'Exploration et de l'Étude des Régions Volcaniques du Kivu. Par André Meyer. Pp. 31+5 plates. (Bruxelles: Institut des Parcs Nationaux du Congo Belge, 1955.) [612

Commonwealth of Australia: Department of External Affairs. Australian National Antarctic Research Expeditions. Reports, Series D: Meteorology. Vol. 5: Heard and Macquarie Islands, 1952. Prepared by the Bureau of Meteorology, Melbourne. Pp. 1+173. Vol. 6: Heard and Macquarie Islands, 1953. Prepared by the Bureau of Meteorology, Melbourne. Pp. 1+169. (Melbourne: Antarctic Division, Department of External Affairs, 1955.) [612

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T. G. Scott & Son, Ltd., Crown House, 143–147 Regent Street, London, W.1
Telephone Number: Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office